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VEGETATIVE AND FERTILE BRANCHES OF COTTON.

THE PROBLEM OF THE IMPROVEMENT OF COTTON IN THE UNITED PROVINCES OF AGRA AND OUDH.

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Economic Botanist,

AND

A. E. PARR, B.SC., PH.D.,

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This note was originally written at the request of the management of the Agricultural Court, United Provinces Exhibition, and in it are outlined the lines of work now in process of development by the United Provinces Department of Agriculture for the improvement of the cottons grown in the Provinces.

This work in its entirety consists of two distinct sections, the production of an improved type, or types, suited to the agricultural conditions of the Provinces and their introduction into general cultivation. Though at the present time the limits of the preliminary experimental work have barely been reached, it seemed desirable for the purpose then in view to outline the entire problem. A few pure races—the outcome of the earliest crosses—are at a sufficiently advanced and promising stage to be subjected to field trial. These are, however, only derived from preliminary crosses, made at a time when a very elementary knowledge of the different types of cotton cultivated was available. With a more complete knowledge of these types, further crosses have been made from which still further improvement is confidently anticipated, but of which it is still too early to speak with certainty.

Though cotton is grown throughout the United Provinces, the tract where it is most largely cultivated and where the crop forms over 30 per cent. of the total *Kharif* area is situated in the western districts. Throughout this area, and throughout the greater portion of the rest of the Provinces, a single species

of cotton is cultivated which has been termed *Gossypium neglectum* Tod. by Gammie, but is classified as two varieties *var. neglecta and var. rosea* of the Linnean species *G. arboreum* by Watt. Within this single species, however, a large number of forms exist which are distinguished by certain minor characters. Thus the flowers may be yellow or white ; the leaves slightly, or deeply, dissected and the glands of the leaf may be present or absent. The lint of all forms is short and coarse though there are degrees in the length of fibre and in the proportion of lint to seed in the *kapas*. Further, though the lint of the widely cultivated forms is invariably white, a certain number of plants can be found here and there in which the lint colour is of a rich red brown, or *khaki* colour.

Such is the condition of the main cotton crop of the Provinces at the present day. Its main characteristics are the shortness and coarseness of the lint and the great confusion of types which are, with few exceptions, grown in one field. These types are the truly indigenous cottons of India. In addition to this the numerous importations of foreign seed, chiefly from America, but also from Egypt, which have from time to time taken place, have left their mark on the Provinces and in most districts plants of this type can be found. The latest and most determined of these importations is that made by the Department of Agriculture, United Provinces, into the cotton districts round Aligarh. The American type can now here and there be found growing as a field crop but, for reasons which are probably partly economic and partly agricultural, its cultivation has not spread and it is unlikely that it will replace to any extent the indigenous forms.

Lastly there is one more group of cottons which is found as a crop within the limits of these Provinces. This is a group characterised by the *Radhiya* of the eastern districts and is the *G. intermedium* of Gammie. Its cultivation is limited to the eastern districts such as Gorakhpur and Allahabad but extends into Bengal. It is found growing alone but more commonly as an element of a mixed crop. The crop occupies the ground for

a lengthy period and begins to yield towards the end of the cold weather. It is, therefore, quite unsuited for cultivation in any area where the cold is sufficient to check growth, and largely for this reason its cultivation is centred in Bengal and extends only to the eastern districts of the United Provinces where the more temperate climate permits of its growth.

In addition to the above, which form the field cottons of these Provinces, there are a few forms which are found as isolated plants scattered here and there throughout and only occasionally found as a field crop. Among these are forms with a *khaki* lint, both of the American and Indian type, and especially the *Nurma*, or red flowered cotton—the *G. arboreum* of most writers. This form is of considerable importance as possessing the longest staple of any cotton indigenous to the Provinces. It is found chiefly in the vicinity of temples where a few plants may be found from the fibre of which the Brahmanical thread is spun. It is a perennial and, like the *Radhiya* already described, very late flowering. Its yield in the first year is consequently very light and its cultivation quite unremunerative as a field crop.

In problems of the present nature success is frequently dependent on the degree to which the aim receives clear definition in the mind. Only by so doing can the best lines on which the work may be developed, be determined with any certainty. It is, therefore, of the utmost importance in the present case to obtain such a clear definition and the problem must now be approached from this point of view.

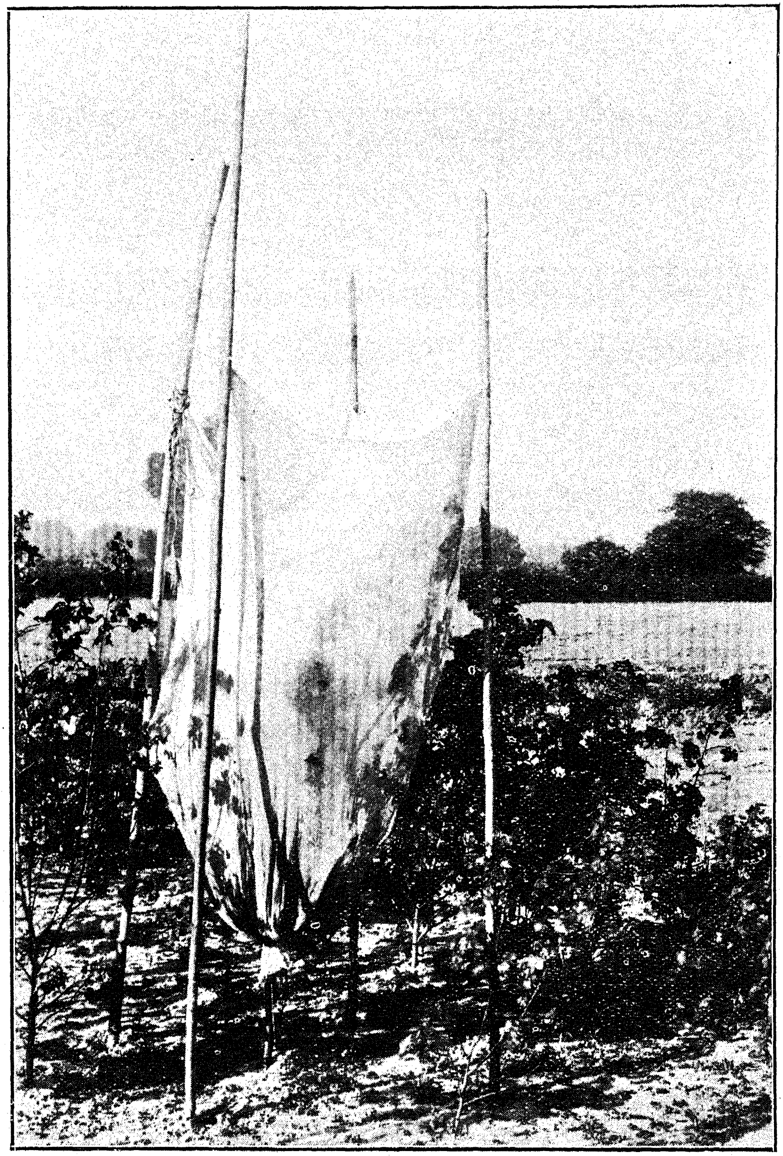
In its agricultural aspect the aim of all improvements should be the increase in the return of a unit area of land. This increase may be procured by a reduction of working expenses in production or by an enhancement in value of the produce, which enhancement may be obtained either by increasing the yield of a given produce or by improving the quality and hence value of the article produced, in which case even a diminution in gross yield may be permissible. In the case of cotton the problem is complicated by the fact that the agricultural is not

the sole aspect. There exists within these Provinces a considerable industry using cotton as its raw material whose interests cannot be ignored. Nor can it be assumed on *à priori* grounds that the agricultural and industrial interests are coincident. In the present instance that the two interests are, to a large extent concurrent is, we think, fairly clear. It may be that temporary circumstances for the time have made quantity of major, and quality of minor, importance; but it is quality which will pay in the long run, and this, therefore, is the point to which most attention has to be paid. There are, it is needless to say, degrees in quality, and it is not suggested that it would be economically sound to produce the finest grades of cotton. What it is desired to aim at, rather, is a cotton of medium length capable of spinning between 30's and 40's and with a silky texture—this latter character in all probability depending on the diameter of the individual fibres.

In the scheme for improvement here outlined, we are not concerned with any such methods as are dependent on the cheapening of the cost of production. In the present case there is little scope for such improvement before the produce reaches the ginning factory, nor are we concerned, except in the broadest manner, with methods for increasing indirectly the fertility of the land on which the crop is grown, such as cultivation and manuring; under present circumstances these too afford small opening for any large improvement. What we are concerned with is that improvement which is dependent on the physiological and morphological characters of the cotton plant itself—characters which are not to any large extent affected by the environment.

It follows from this that any practical improvement can only be obtained as the result of a close study of the characteristics of the cotton plant which study must precede any work aiming at a practical end. The work, therefore, falls roughly into two divisions, the purely scientific preceding and the practical following.

PLATE I.



A. J. I. A PLANT PROTECTED AGAINST CROSS-FERTILIZATION.

We have already shown that the cotton crop as it is grown throughout the Provinces consists of a large mixture of types. The first step of importance, therefore, is to find out the units of the crop, by which is meant the number of forms which can be isolated and grown in pure culture. Having obtained these, the second step is to find out the unit characters of the plant, that is, the characters of lowest magnitude which can be traced as units from generation to generation. This may be explained by a concrete example. The flower of the cotton plants of these Provinces are of three colours, the red flowered *Nurma* and the yellow and white flowered *Desi*. There also occurs in the Punjab a pink flowered cotton, though we have no record of its occurrence in these Provinces. Now these four forms of flower colour are not four separate characters, but arise from two only, each of which may be present or absent. On the combination of these two characters depends the resultant colour of the flower. Thus the two colour characters are yellow and red. When both colours are present the flower has the full red colour; when red is present and yellow is absent the flower is pink, while if yellow is present and the red absent the flower is yellow. Lastly, if both are absent, the flower will be white. That this represents the true facts is shown by the ease with which it is possible, starting with only pure red and pure white flowered types, to breed out pure pinks and yellows, and in like manner it is possible to obtain pure white and pure red flowered plants starting with the yellow and pink forms only. From this single simple example some idea may be gained of what is meant by a unit character. The method by which such unit characters are determined is also indicated to some extent in the above, and consists usually in crossing pure types differing in one or more characters and observing the behaviour of these characters in the next and subsequent generation.

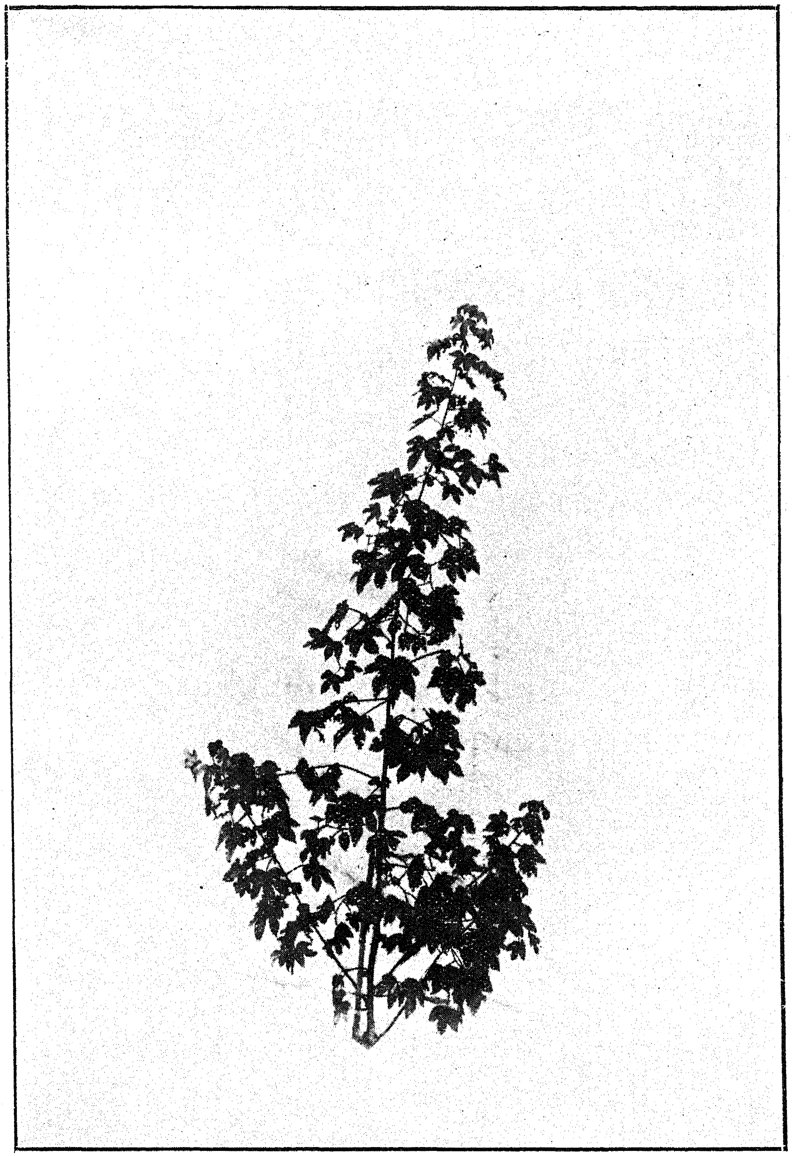
It is possible that a certain amount of practical result may be obtained directly from the preliminary isolation of pure types. In the extensive mixture of forms found throughout the cotton growing area it has been found that comparatively few pure

types exist. The remainder of the crop is composed of intermediate forms, the result of natural cross-fertilization. Such intermediates will never breed true but give an indefinite number of forms together with a few plants agreeing with one or other of the pure types. Now, in such a mixture, there can be little doubt that some of the forms are inferior to others and it is possible that, by isolating the pure forms, a superior form may be found and its cultivation introduced. There is no prospect of improvement of quality by such means, but an improvement in quantity is to be looked for. Thus some of the *Desi* types of cotton are notably heavy yielders with a high percentage of lint and in some districts even now are grown in a nearly pure state. The purification, and subsequent distribution, of these gives one line of improvement, but it must be emphasised that that improvement is practically limited to quantity. Work on these lines is now in progress at Aligarh.

That there is opening for improvement by direct plant selection within such a pure culture admits of no hope. The most selection can here do is to check any diminution in yield, chiefly by rigorously maintaining the purity of the seed. Owing to the extent to which cross-fertilization takes place in nature it is a matter of some difficulty even to keep the more distinct types in a state of purity when they are grown on a small scale and, even when working on a big scale, it is essential to undertake precautions such as roguing to maintain the purity of the crop. It will be readily understood, therefore, that it becomes a matter of practical impossibility to separate those small and scarcely perceptible characters on the selection of which improvement within a pure type depends.

Thus far we have considered an improvement in the gross outturn only—the quality remaining practically the same. This, however, is not the main direction in which improvement is to be expected. This, as we have stated above, is to be found in the improvement of the quality, length and fineness of the lint. For this purpose we must turn elsewhere, to the results, that is, which have been obtained in our search for the unit characters.

PLATE II.



A. J. I. AN EARLY FLOWERING PLANT.

It is at this stage that the clear picture which we have formed of what it is desired to procure will be of the utmost importance. Let us for a minute examine this picture in greater detail than we have hitherto. It is a plant, which, when sown at the beginning of the rains, will be ripening fruit by the beginning of October, that is, it must be in flower by the end of August giving a vegetative period of about 70—80 days. In other words it must be early flowering; it will be vigorous, a good yielder with a large boll and a high percentage of lint; the lint must be fine and silky and of a length rendering it suitable for spinning between 30's and 40's, which may be placed roughly as 1 inch.

Of other points of secondary, but, nevertheless, sufficient, importance to render them worth consideration may be mentioned the obvious advantage of a red flowered form. We have already drawn attention to the dangers of natural cross-fertilization. There is also the danger of seed admixture. These are very real dangers which must be faced or a new form may easily be swamped at the start by either of them and thus lost. The advantage of some such character as a red flower, by which a casual inspection will at once disclose any admixture or impure plants would form a check of inestimable value in the early stages of introduction.

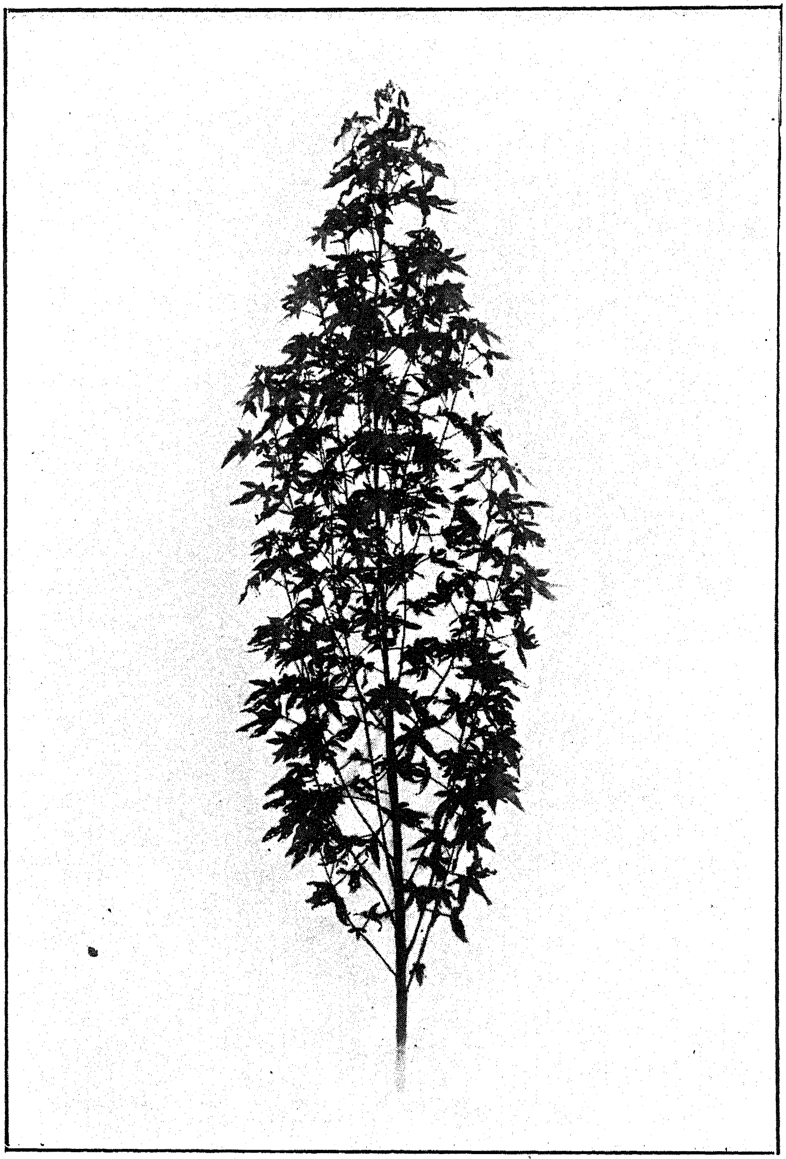
The material from which it is proposed to obtain the plant just described has already been briefly detailed. Considered from this point of view, it consists of the series of forms all with the early flowering characters and some possessing the heavy yield and good percentage lint, but lacking both the length and fineness.

There occurs in isolated places among these forms a type, allied to the Hinganghat cottons of Central India, possessing the silky fibre but lacking the length of the latter. There are again the cottons of the eastern districts; these, however, have a late flowering period, nor is the lint of much value while the percentage is very low. Lastly, there is the red flowered *Nurma*, very late flowering but possessing a good staple, moderately

silky and having red flower and foliage. If we go outside these Provinces there are also the true Hinganghat plant, an early flower with long and silky lint but incapable of producing a good yield or sufficiently robust; the Broach cotton with a good staple but very late flowering, and the Assam cotton whose only good character is the size of boll and percentage lint, the lint being, however, excessively short.

Before considering how this material is to be utilised we must examine the conditions under which this work has to be carried out. Here the difficulties are considerable. Thus it has been found impossible to use the Broach cotton as a parent, the crosses from it appearing almost sterile. Again, cross-fertilization in nature has been found to occur on a scale which renders it imperative to use only the seed from protected flowers, and the labour involved in such protection is considerable. Again, continued self-fertilization, such as occurs with protected flowers, has been found to lead to a considerable degree of sterility so that the breeder has to beware of falling into either the Scylla of mixed offspring or the Charybdis of no offspring at all. Lastly, but not of the least importance, is the impossibility of ascertaining, except in a very limited number of cases, the quality of the staple until it is too late in the season to procure seed from protected flowers. By the time the boll ripens and exposes the cotton the plant has practically ceased flowering and it is impossible to obtain self-fertilized seed. At certain stages, then, it becomes a matter of speculation as to which plants shall be taken, for, so far, no correlation has been found by which the quality of staple can be determined before it can be actually handled. When it is noted that, to take one case which occurred in practice, it has been found that out of some 400 plants one only possessed the desired combination of characters, the speculative nature of the proceeding and the necessity of dealing with large numbers becomes apparent. In the event of failure to self-fertilize the desired plant it will be necessary to rattoon it and procure seed from it next season, thus losing a whole year, with the alternative of using seed

PLATE III.



A. J. I. A LATE FLOWERING PLANT.

which may or may not be pure. This difficulty is far the most important that has to be faced in this work.

Such are the conditions and such the materials with which it is proposed to produce the types of plant of which a description has been given above. The length of staple occurs in the Broach, *Bani* and *Nurma* cottons, but, as has already been stated, Broach has been found unsuitable owing to the sterility of the crosses. We are left then with the *Bani* and *Nurma* cotton, the former of these being altogether too weak in habit and light in yield to form a field crop in these Provinces, while the latter flowers too late to give any yield in the first year and has to be grown as a perennial. Moreover in both these forms the boll is small.

Silkiness is characteristic of the *Bani* cotton and is confined practically to that kind.

Hardiness and yield combined with a high lint percentage are essentially the characteristics of the *Desi* cottons of the Provinces and more especially of the white flowered forms. While for size of boll the cotton of Assam stands before all others.

The *Nurma* alone of the Provincial cottons possesses the red flower which, for the reasons given above, is a desirable character in the plant we have outlined.

In the earlier experiments two crosses have been relied on for practical results. These are a cross between *Nurma* and the short stapled but silky form of *Bani* found in these Provinces, the possibilities of which cross were indicated as early as 1870 by Major Trevor Clarke, and one between *Nurma* and white flowered *Desi*. In this former cross we rely on the *Nurma* to obtain length of staple and the red flower, while from the *Bani* we hope to derive the silkiness of fibre and the early habit. The plant is likely to be somewhat deficient in size of boll, and consequently yield, and in percentage of lint since neither parent possesses these characters to any marked extent.

In the latter cross length of staple and percentage of lint may both be expected, combined with the red flower, but the silkiness of the fibre will be lacking.

These two crosses have been actually effected and pure races isolated of which we give below a report by Mr. A. F. Horsman, on small samples of the lint from each; the first is from the former, and the second and third from the latter, cross.

"Sample 131. Very good cotton, will spin 20's to 30's warp, even staple $\frac{3}{4}''$ to $\frac{7}{8}''$ long; silky and colour good and would spin 36's weft.

"It was compared with some fine Cawnpore machine ginned cotton (*Gangapar*) which was fully $\frac{1}{8}''$ to $\frac{3}{16}''$ shorter in staple and will spin up to 16's only.

"In regard to prices, I should value it at Rs. 325 per candy (784 lbs.) as against Rs. 275 for fine Cawnpore machine ginned cotton and I consider it equal to fine Broach.

"Sample 401. This is better than ordinary *Desi* but not so good as No. 131. The staple is not so regular nor as fine but is rm and of fairly strong fibre; would spin 15's to 20's.

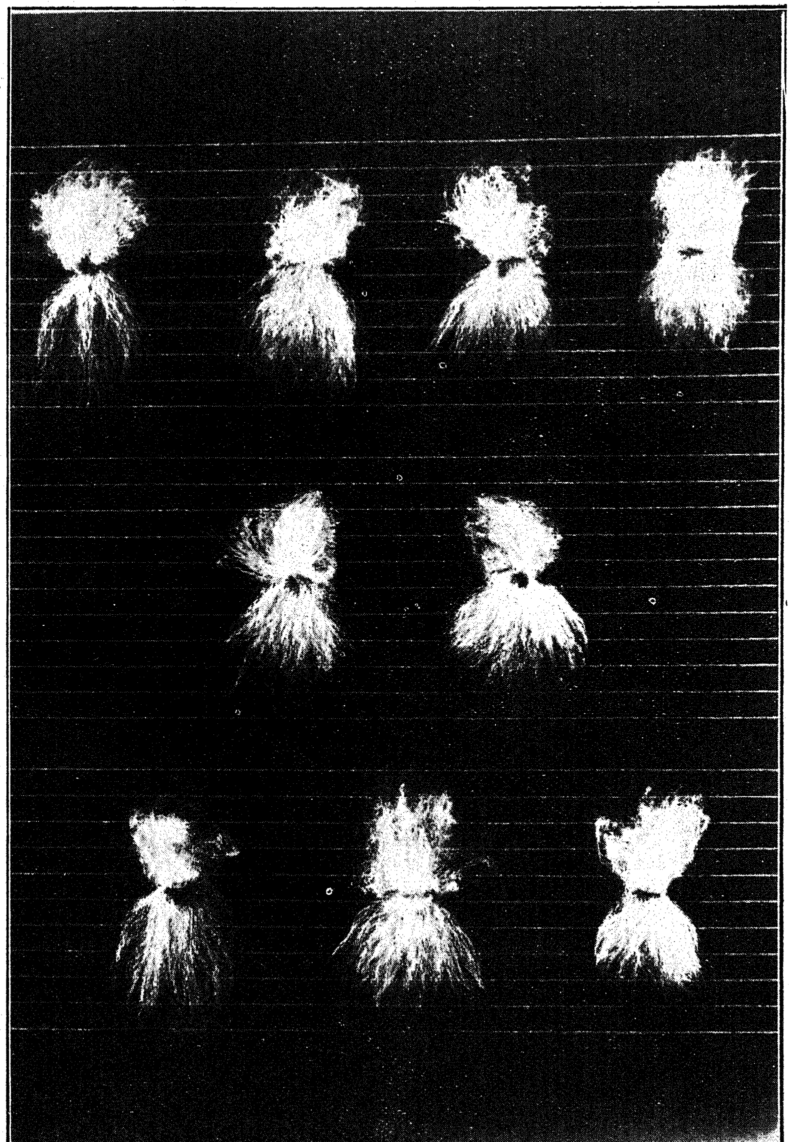
"Sample 651. This is between Nos. 131 and 401, not quite o coarse as No. 401 but very good for *Desi* cotton.

"Sample too small to form a definite opinion."

It remains only to add that this report is given on samples which were taken without any idea of having them valued. The object in taking them was to obtain as much seed as possible o that they contained, in addition to the lint from healthy bolls lso that from badly diseased bolls. During the season 1909 ne boll worm was exceptionally prominent and the percentage f diseased bolls very large. These reports, therefore, do not, in l probability, err in the direction of over-estimating the value f the samples. This remark applies especially to the sample 401 hich, we believe, to be, in reality, of greater value than the eport seems to indicate, the irregularity especially noted being ue to the presence of a high proportion of lint from diseased bolls.

These experiments are yet in their infancy, and the limits of nprovement by no means reached. Numerous other crosses e now in various stages of cultivation and it is hoped that these ill add still further improvement. It is, however, too early to efer to these in detail.

PLATE IV.



A. J. I. Top Row. Left, Nurma Parent. Right, Bengal Parent.
Middle Row. 1st Generation of Cross.
Bottom Row. 2nd Generation of Cross.
Left, Long Staple—Centre, Medium Staple—Right, Short Staple.

The production of a plant with characteristics which render it suitable for cultivation in these Provinces, and which at the same time gives a produce of enhanced commercial value is only one part of the problem of improvement. There remains the all-important question of the means by which such a plant can be introduced into general cultivation. We are here faced with the conservatism innate to all agricultural populations. The initial stages of introduction into general cultivation of any new plant are always a matter of some difficulty, but this difficulty is here enhanced by the ease with which cottons cross-fertilize and the consequent difficulty in keeping any new race pure during the first few years of its introduction. There is also the difficulty of inducing the consumer to pay the full value for an article which is not well known and only available in small quantities or, if he does pay the full price, in insuring that the actual cultivator reaps the benefit. In a case like the present, where deterioration may so readily occur as the result of cross-fertilization, it seems essential to success that full control shall be kept over the crop during the early stages. The essential features of any scheme for introduction therefore are:—Firstly, to withhold introduction of the produce on to the market until it is available in sufficient quantity to attract purchasers and secondly, to retain under direct control what may be termed a centre of purity for the crop, that is, a central area, or seed farm, in which full precautions can be taken to keep the crop in a state of purity.

The controlling factor is the minimum amount of cotton which will attract the buyers, and the area of this seed farm will be determined by the area it will be necessary to sow to provide this minimum, for it follows from the first condition that the cultivation cannot be entrusted to the cultivators until the year it is proposed to place the produce on the market. Placing this minimum at 500 bales (of 400 lbs.) the area to be sown must be some 1,300 acres in the first year, seed for which will be given from an area of about 90 acres. This, then, is the area which must be sown in one season and over which direct control of the crop must be maintained and from which the pure seed will be

distributed to selected cultivators who control between them about 1,300 acres of land.

This distribution in the first year is a comparatively simple matter, but the problem becomes of much greater complexity when the still wider distribution of subsequent years is considered.

The important point to bear in mind in this connection is that the purity of seed is likely to be inversely proportional to the number of years the crop is removed from the time when it was grown on the seed farm. We have no direct information as to the amount of impurity introduced in a single year, but there can be little doubt that it will be appreciable. The conclusion which may be drawn from this is that on no account should seed of a given purity be mixed with seed of a lesser purity and this point must be clearly kept in mind in any scheme of introduction. In practice this demands, at least during the first few years of introduction, that some records be kept of the area in which the new crop is grown. This record will show the particular area under any degree of purity and the *kapas* of each area, so demarcated, will then require to be ginned separately. Interpreted into figures this means that the seed from the farm will have to be distributed to selected cultivators controlling some 1,300 acres actually under cotton in a single season. These cultivators will each year receive a fresh supply of seed from the farm and will not sow seed from the crop grown by themselves. This latter crop will be harvested separately and separately ginned, and the seed distributed to a second series of cultivators controlling some 20,000 acres of land under cotton. In the next year these two areas will be harvested and ginned separately, the original areas of 1,300 acres being again supplied with seed from the farm, the 20,000 acres area being supplied with seed from the crop grown on the 1,300 acres, while the seed from the 20,000 acres will be available for still wider distribution. In this manner a series of, as it were, waves will be established, emanating from the seed farm, which should, in a short period, establish the crop on a firm basis.

Such, in outline, is the scheme for introduction of improved types of cotton. That it can be established with the mathematical precision of the geometrical progression here outlined is hardly to be expected, but there is every hope that sufficient approximation can be obtained to attain the desired result.

PEACH GROWING AROUND PESHAWAR.

By W. ROBERTSON BROWN,

Superintendent of Farms, North-West Frontier Province.

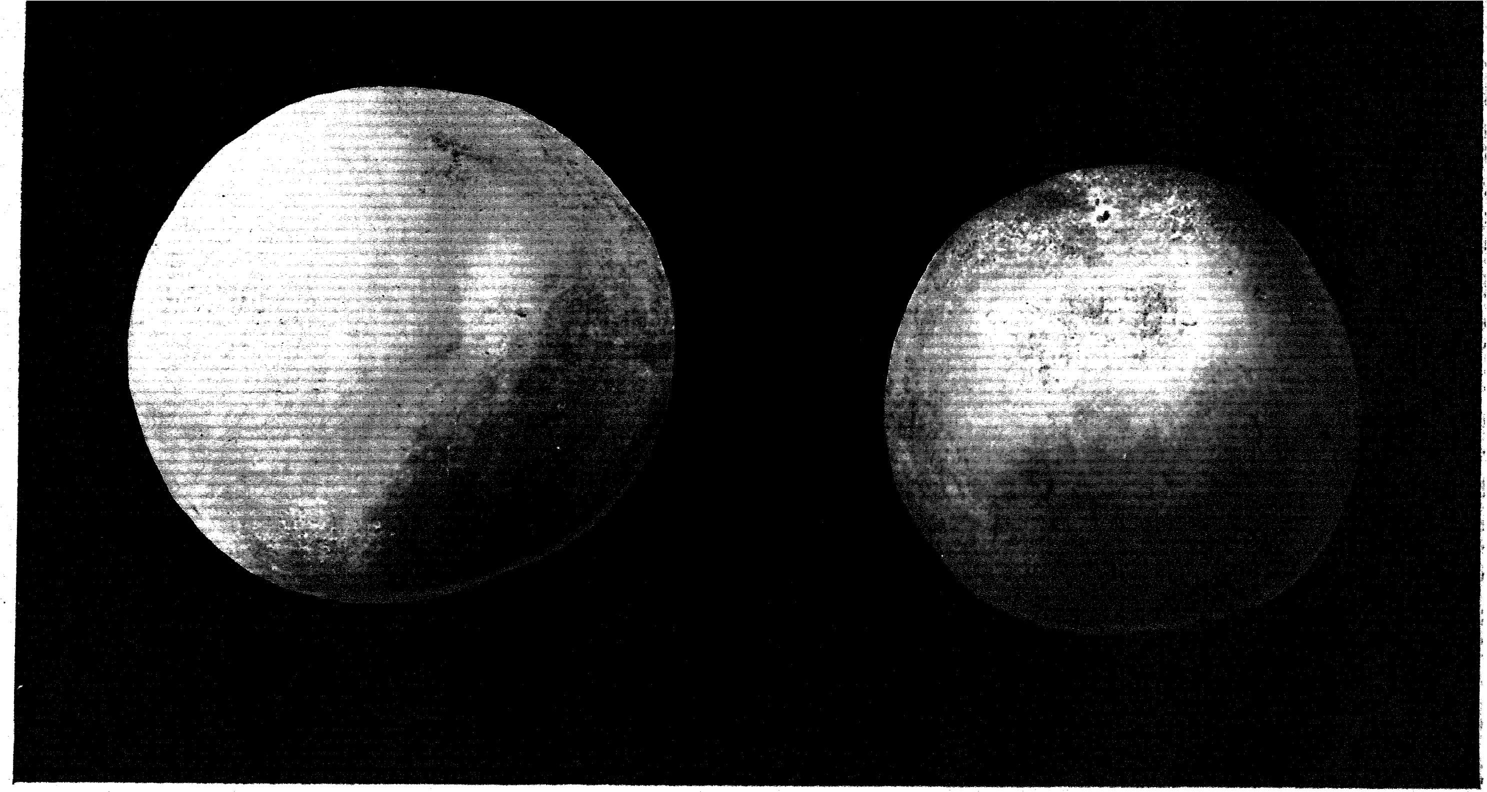
Situation of the Orchards.—Within a radius of 10 miles from eshawar city, there are probably 100 acres of peach orchards. eaches are also interplanted to some extent in the pomegranate ıd plum gardens which lie in the immediate vicinity of the ty. The villages of Bahadur and Landi are specially renowned r the size of their orchards and the superior quality of the aches they produce. The orchards are contiguous and their rying levels show that they ensure efficient drainage.

Average Extent of Orchards.—Peach growers are rarely chardists pure and simple: they are zemindars, and the inting of an orchard forms part of their agricultural rotation. ie orchards range in extent from half an acre to occasionally o acres.

Quality of the Soil.—The red alluvial loam around Bahadur l Landi is remarkably fertile. Wherever the peach orchards established, the soil is of this kind—red, deep, free and natural-well-drained.

Irrigation.—Practically every orchard is sufficiently irrigated her by the rich muddy water of the Bara, or from the Kabul ver canal. The orchards treated from the Bara water are rkedly superior in productiveness and quality of the fruit to se irrigated by the Kabul River canal. A few orchards are r-irrigated, as occasionally water is given when the crops are ening so that the fruits lose greatly in flavour. In the njab, the best peaches are produced in orchards which are

PLATE V.



A. J. I. PEACH "SAFED." PEACH "LAL."

irrigated by well water. Punjab canal-irrigated orchards invariably do not thrive and are unfruitful. Peshawar canal-irrigated orchards, on the other hand, are naturally drained and therefore suffer less from stagnation. Plate V shows one of many hundreds of Punjab peach trees which were killed in 1908 by the combined ill effects of excessive canal irrigation and an unusually heavy monsoon. These peaches were mostly planted between oranges. It will be seen from the picture that the latter were not injured by the excess of water.

Protection.—Peshawar plum, pear and pomegranate orchards are protected by unsightly and almost formidable mud walls. The soil in these orchards is always moist and the atmosphere damp. It is quite the contrary with the peach orchards; they are entirely in the open and unreservedly exposed to wind, sun and storm.

Trees propagated from Seeds.—There is not an orchard of budded or grafted peach trees in Peshawar. It is probable that there is not one budded peach tree producing fruit. The Peshawar orchardists propagate from seeds only: they are generally of opinion that peaches cannot be budded. Even those who know that budding can be done and who can actually perform budding work, do not consider that budding is worth the trouble. There is not a nursery-man in Peshawar who undertakes to supply budded plants. In January 1910, some hundreds of budded peaches were introduced into Peshawar by the Hon'ble the Chief Commissioner. All these plants were given fair treatment and have grown remarkably well: they are now perfect in health and shape and on the average are one-half larger in size than seedling peach plants which were set out at the same time.

Three Outstanding Varieties.—Though Peshawar peaches vary greatly in size, shape and flavour, the fruit growers and fruit dealers roughly class them chiefly according to colour into three kinds, *viz.*, *Safed*, *Lal* and *Pila*. It is said that these three kinds reproduce themselves fairly true to colour from seedling plants and that other important characters are not

constant. Plates VI and VII represent good types of *Safed*, *Lal* and *Pila*. The fruits illustrated are described below :—

Safed.—Is the earliest : it ripened late in July. Size is large, shape almost quite round ; nose very slight ; colour even white ; suture scarcely perceptible. The flesh is white even around the stone and is very soft, juicy and melting. The stone is fairly large and the flavour is good. Its weight is 16 tolas.

Lal.—Is the second early ; it ripened on 3rd or 4th August ; size large ; nose decided ; colour flushed and shaded crimson ; suture slight. The flesh which is veined crimson and deeper around the stone is fairly firm and moderately juicy. The stone is medium in size. The flavour is good. It weighs $15\frac{1}{2}$ tolas.

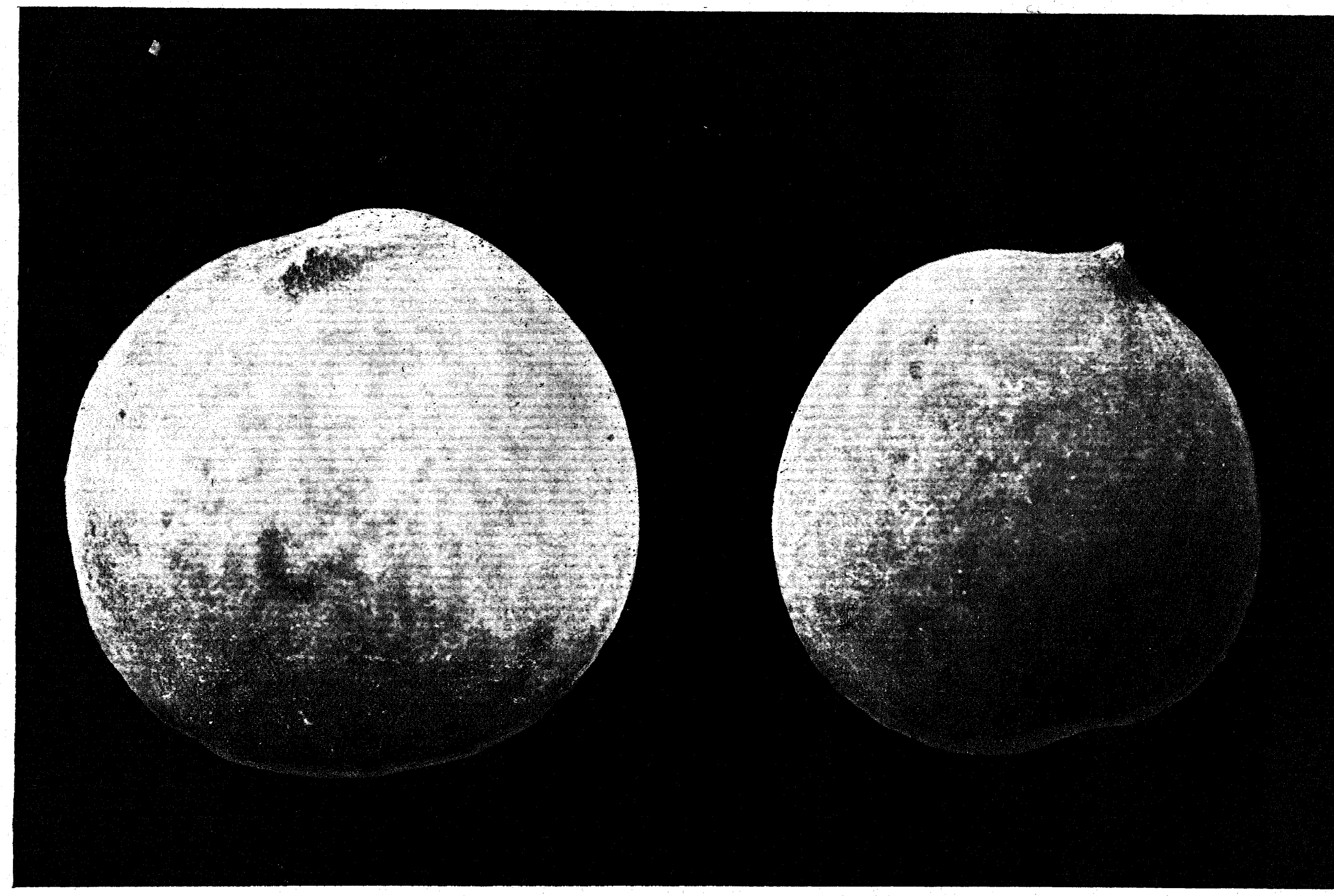
Pila.—Is the latest ; it ripened on 8th August (fruits were picked till 20th August). Size medium ; nose entirely absent ; beautifully round in shape, suture absent. The flesh is golden yellow throughout ; firm and juicy. Flavour sweet and delicious. It weighed 14 tolas.

There are good intermediate varieties of these types. *Lal-Pila* and *Lal-Safed* are most frequently found. In all round merit, the three varieties described are equal to high class English outdoor wall peaches.

Setting out.—Two seedling peaches, 16 months of age, are planted together in blocks or beds $16' \times 16'$ or $18' \times 18'$ apart, and the pits in the centre of these blocks in which the trees are planted are 1 foot in diameter and 1 foot in depth. The orchardists plant two trees in each block in the hope that at least one of the plants will flourish. But he never removes the second plant if both grow away. The average life of the Peshawar peach orchards is under eight years. The Lahore peach orchards are profitable up to their twelfth year.

Seed Sowing.—A few careful cultivators take seeds from selected fruits only, but here commonly there is no selection. In October a seed bed is prepared, varying in size according to probable requirements and the seeds are sown broadcast and thickly at a depth of about three times the size of the seeds. The young seedlings are not thinned. When planting time

PLATE VII.



PEACH "PILA."

PEACH-NECTARINE.

PEACH ORCHARD, $2\frac{1}{2}$ YEARS OF AGE, WITH VEGETABLE INTERCROP.

comes, 16 months later, the seedlings are attenuated plants quite unfit for orchard planting and can be purchased at Re. 1 per hundred.

Catch Crops.—Maize is taken from the young peach orchards as a *kharif* crop for two or sometimes three years, or *jowar* is sown for fodder. Practically any catch crop desired is grown for at least two years. Around Lahore, vegetables, and frequently oats, are taken from young peach orchards. Plate VIII shows $2\frac{1}{2}$ years old orchard with an inter-crop.

Manuring and Cultivation.—For maize or *jowar* a dressing of manure is given. The orchard rows are kept stirred and free of grass and weeds for at least four years. Later, in many orchards, cultivation consists in an annual forking over of the soil directly around the trees.

Thinning of the Fruits.—The trees are severely over-cropped. Thinning of the fruits is never carried out. When suggested, the idea is scouted as ridiculous. On English peach walls, one fruit per square foot of covered wall is the maximum crop permitted if good fruits are desired.

Ripening.—*Safed, Lal* and *Pila* of all shapes and sizes are planted promiscuously throughout the orchard, but ripening takes place in the order named. If budded plants of these three types were planted in separate rows or blocks, economy would be gained and one watchman could do the work where three or four are now employed : picking would also be made easier. The Peshawar fruit agents would give greatly enhanced prices for blocks of single types. Irrigation should be sparingly given.

Picking.—The bulk of the peach crop is picked without climbing the trees, for step ladders are unknown in Peshawar orchards and the flexible branches of the trees are gently pulled down towards the pickers. For fruits which cannot be reached from the ground, they nimbly climb the trees and as this operation is done barefoot, little harm results. Nevertheless step ladders would be useful. The fruits are picked when they show colour, but are very far from being ripe. It is chiefly on this account that good conditioned peaches are never seen in the markets.

Marketing.—The peach crops are sold in one of four ways, *viz.*, (i) if the owner of an orchard is poor and he urgently requires money, he sells the estimated crop in January or February to a fruit agent. The price received is in this case very poor: frequently not better than Rs. 100 to Rs. 120 per acre: (ii) the crop is sold when the fruits are approaching the period of ripeness. Rs. 200 to Rs. 300 per acre is the average price received at this time; (iii) fruit agents purchase special varieties from selected trees for despatch to distant stations. Rs. 3 to Rs. 5 per maund are received by the growers for the selected fruits; (iv) the fruit growers pick and market their own fruits in Peshawar. One maund of peaches per tree is considered a very good crop. About 13,500 ten-seer baskets of peaches are despatched from Peshawar from 15th July to 15th September. Ordinary fruits are sent to Peshawar for disposal in large open flat baskets similar to those shown in Plate IX. Fruits to be sent to distant stations by rail are packed in small baskets which carry 10 seers and cost from annas three to annas four. The baskets are conveyed to the city and to the railway station on a cart drawn by two labourers.

Packing.—Grading is practised in a loose fashion. The best peaches are reserved for the 10-seer baskets; the seconds for topping the big flat baskets and the "chipped" fruits are heaped in separate baskets or sold on the spot to villagers, or to the hawkers who have stances during the fruit season at almost every half mile within ten miles of Peshawar. The chipped fruits are very inferior.

The foliage of the orchard trees is slipped from the young shoots of the current season for packing. Each picker, as he requires packing, runs his hands smartly down the shoots and leaves quite 80 per cent. of these as bare. The array of spindly leafless shoots presented in August gives the impression that the peach orchards have suffered heavily from a plague of voracious defoliating caterpillars. Peach foliage is undoubtedly suitable for local packing, but it is short-sighted policy to maim the fruiting trees. The lives of orchards are shortened by one-third by this

PLATE IX.

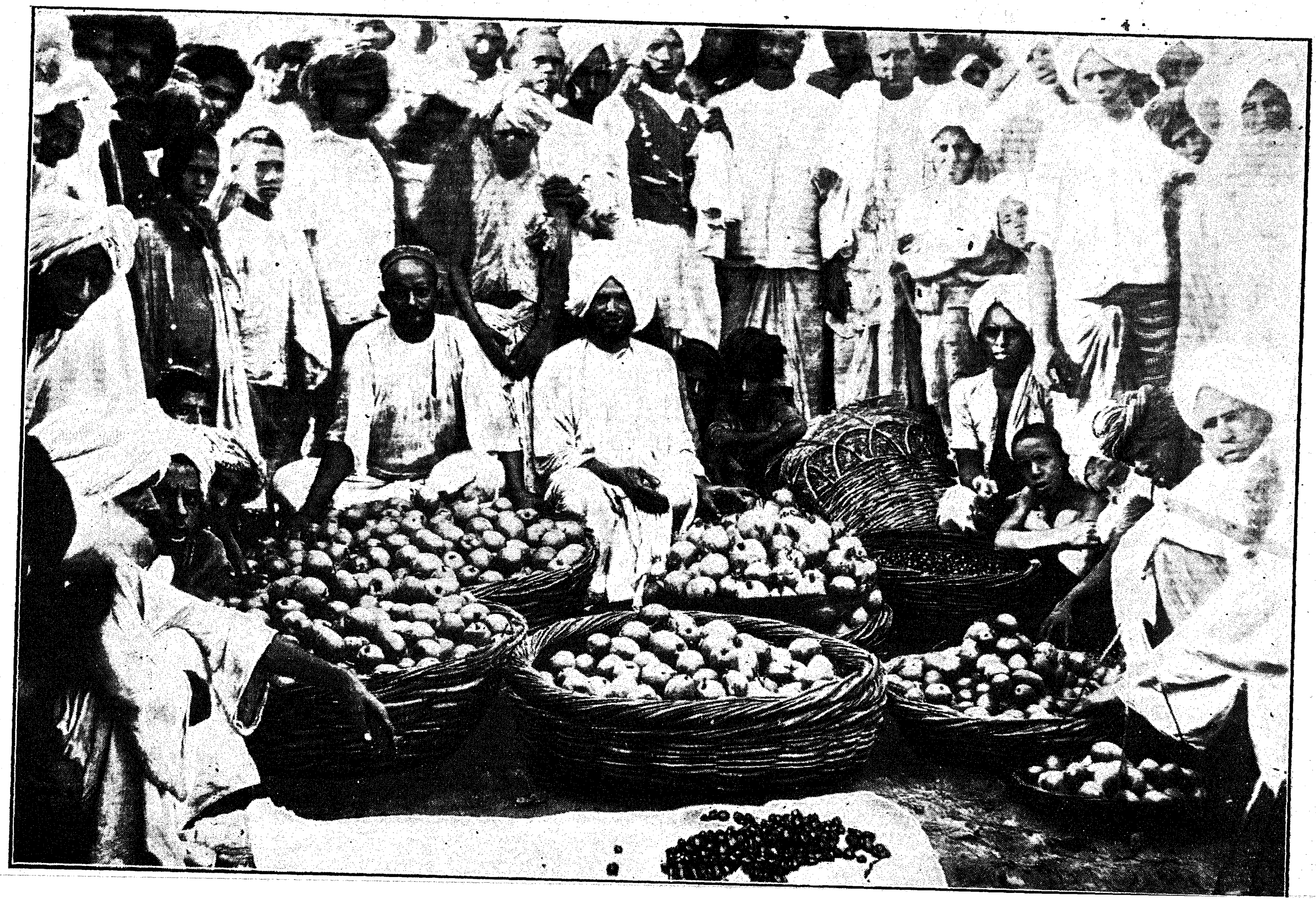


PLATE X.

YOUNG PEACH AFFECTED BY "GUMMOSIS."

practice: diseases are prevalent in consequence and the weakened shoots cannot uphold their fruits. Every orchardist could easily grow a seed bed of peaches for the supply of foliage.

Fruit Agents.—The men known as "Fruit Agents" are Peshawar fruit sellers. They have business connections with fruit dealers in Calcutta, Bombay, Lahore, Delhi and other large cities and towns. They send skilled men to pick the fruits and see the baskets on rail. Bills are submitted for all charges including the agent's commission charge for 0-4-0 per basket despatched. Prepayment is insisted on from unknown purchasers. Occasionally when peaches are plentiful and cheap, the Peshawar agents purchase and forward fruits to their distant agent friends to be sold on commission. The money realised, less the usual commission charge of annas four per basket, is remitted to the Peshawar agents. There appears to be the most perfect good faith amongst the fruit agents throughout India in their business transactions.

Railway Troubles.—The fruit agents complain bitterly of the time they are forced to lose at the railway station when booking and forwarding. They and their clients frequently suffer loss and disappointment by theft of the fruits in railway transit.

Diseases and Insect Pests.—Peach insect pests and diseases have not yet been studied in the North-West Frontier Province. "Gummosis" is the most common disease. (Plate X.) The injury done in stripping leaves for packing is undoubtedly the chief cause of the unfortunate prevalence of this disease. The severe annual attacks of green fly are also due to the same deplorable practice. The weak defoliated shoots fall easy prey to sucking insects. Peshawar peach orchards would be remarkably free from disease and insect pests if they were properly treated.

THE BAMBOO WATTLE SILO.

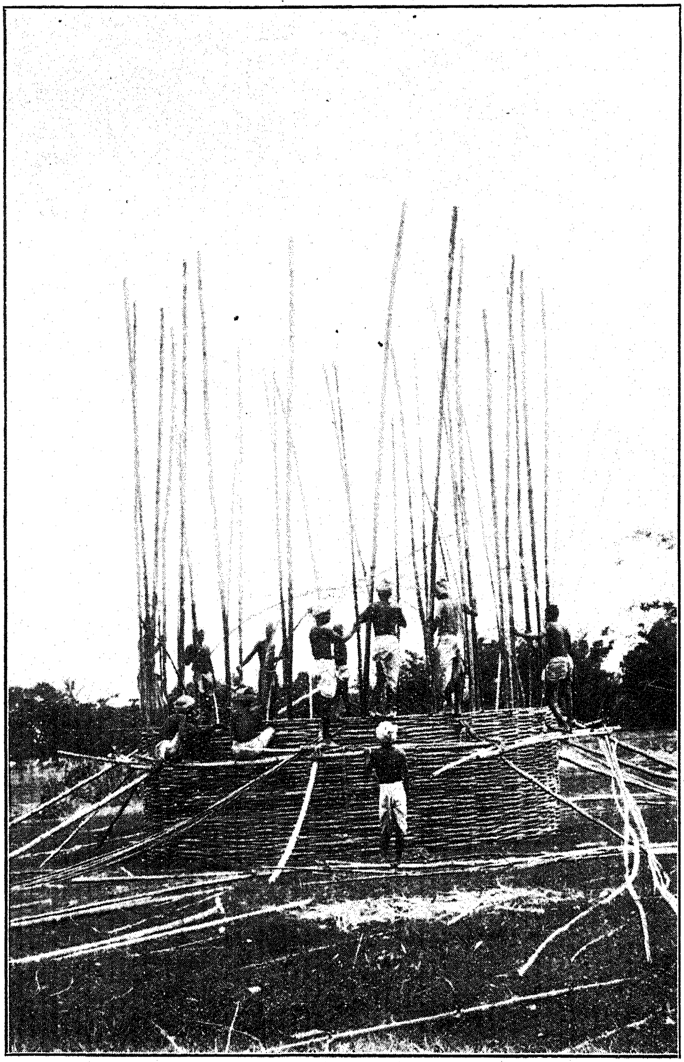
(An Attempt to Construct a Cheap Indigenous Silo.)

By BERNARD COVENTRY,

Offg. Inspector-General of Agriculture in India.

History of Siloing.—The practice of preserving cattle food n a green and succulent condition is of some antiquity, but it is nly within the past 25 years that siloing, as now commonly :nown, has been in vogue. The earlier silos used by people in Europe were simply pits or trenches dug in the ground. Later, hese were made of stone, brick, or concrete, and filled with green naterial, cut or uncut, to which pressure was applied, often not ess than 100 lbs. to the square foot. Siloing in stacks was also ractised for a time. The material, which in this case was uncut, vould be gathered together in the shape of a stack: ropes or hains would be thrown over it to which heavy weights were ttached and the necessary compaction thus secured. Both these nethods of pit and stack siloing were found to a great extent unatisfactory in that either the cost of construction was too heavy, r the loss by decomposition was too great, or from both these auses: the quality of the silage, too, was not all that could be esired. It was not until 1876 and following years when dairyng became common in America and green food a necessity all he year round, that the attention of the more intelligent farmers vas applied to the production of a more suitable method of silong. The great extent to which Indian-corn or maize is grown n that country undoubtedly favoured the experiments, for it is iow generally conceded that maize is the best silo plant in existnce, though as I shall show later, sorghum runs it very close nd, in my belief, in point of yield per acre entirely beats it.

PLATE XI.



A. J. I. SILO UNDER CONSTRUCTION.

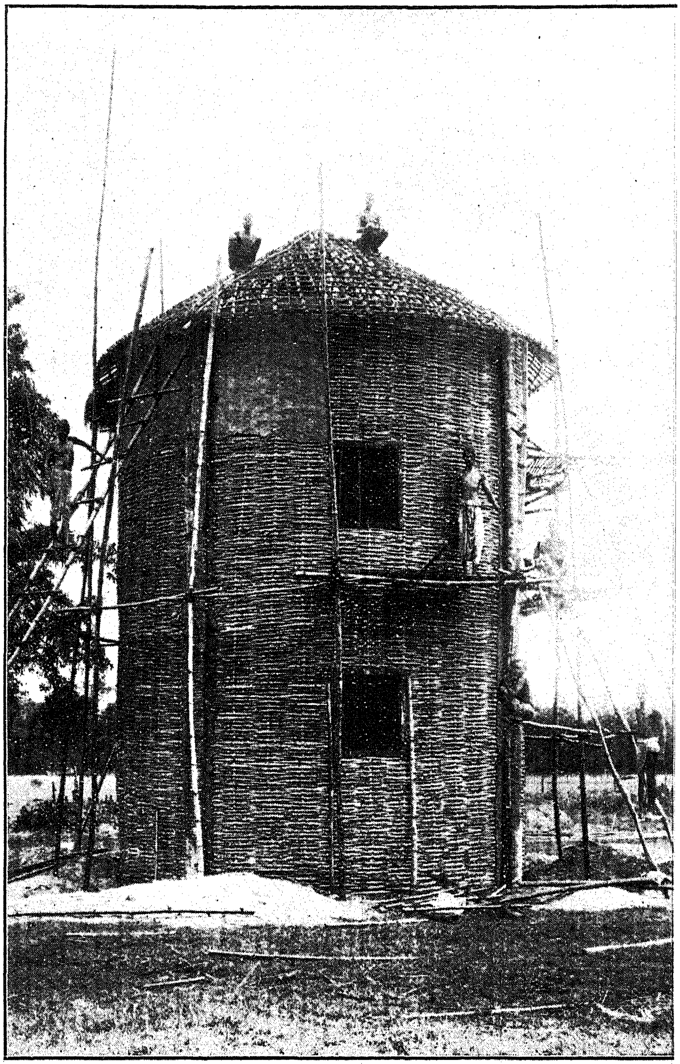
The Modern Silo.—The chief features of the modern silo are that it is narrow and deep instead of broad and shallow, so that pressure is secured from the material itself instead of weighting with stones and other heavy material. It is partially or entirely (mostly the latter) above ground. It is generally round rather than rectangular because in that shape it has relatively greater capacity, can usually be built more cheaply, and its form greatly facilitates the even settling of the silage. It is moreover constructed in such a way as to prevent the ingress of air and moisture at the sides and bottom. The principle on which it acts is as follows. As soon as it is filled with green material cut or uncut (preferably the former as it will settle more quickly and evenly), fermentation sets in and gases (chiefly carbonic acid) are formed which drive out the air until a point is reached when fermentation or combustion ceases for want of air. The great depth of the silo is instrumental in bringing about this point of equilibrium, for the pressure of the material causes such compaction that the air is unable to penetrate. The sides of the silo should likewise be so constructed that air is unable to enter. If either of these features are defective and ingress of air is allowed, the equilibrium will be destroyed and combustion will again set in. It will thus be seen that good compaction and exclusion of air are essential conditions in the successful making of silage. Temperature, too, has a considerable bearing on the quality, for the higher and quicker the temperature rises after the filling of the silo the sooner will the action of the fermenting organisms be arrested and the sweeter will be the silage. An excess of moisture on the other hand in the plant will often keep the temperature low or will rise but slowly, in which case the fermentation will not be checked soon enough and sour silage will result. The deeper a silo the better will be the quality of the silage, and it has been found in America that a depth of 40 feet has usually produced the best results. Such a height, however, adds greatly to cost of construction and of filling. The quality obtained at much lower depths, such as 25 and 30 feet, has been found satisfactory and it is not necessary to go beyond these limits in order to

obtain good results, but anything below 20 feet is not recommended.

Experiments in India.—The success which has attended the use of the round silo in America led the writer of this article to experiment with them in India. In 1900, one was constructed of brick at Dalsing Serai, Tirhoot, measuring 20 feet in height and 16 feet in diameter. Owing to its success and the great economy with which green fodder could be preserved, another of the same dimensions was erected by Mr. Hay-Webb at the Mooktapur Indigo Concern in Behar with the same satisfactory results. When the Pusa Farm was built, silos were, in consequence of the success of those at Dalsing Serai and Mooktapur, also put up at Pusa, but owing to defects due to faulty construction the Pusa silos have not made the best quality silage.

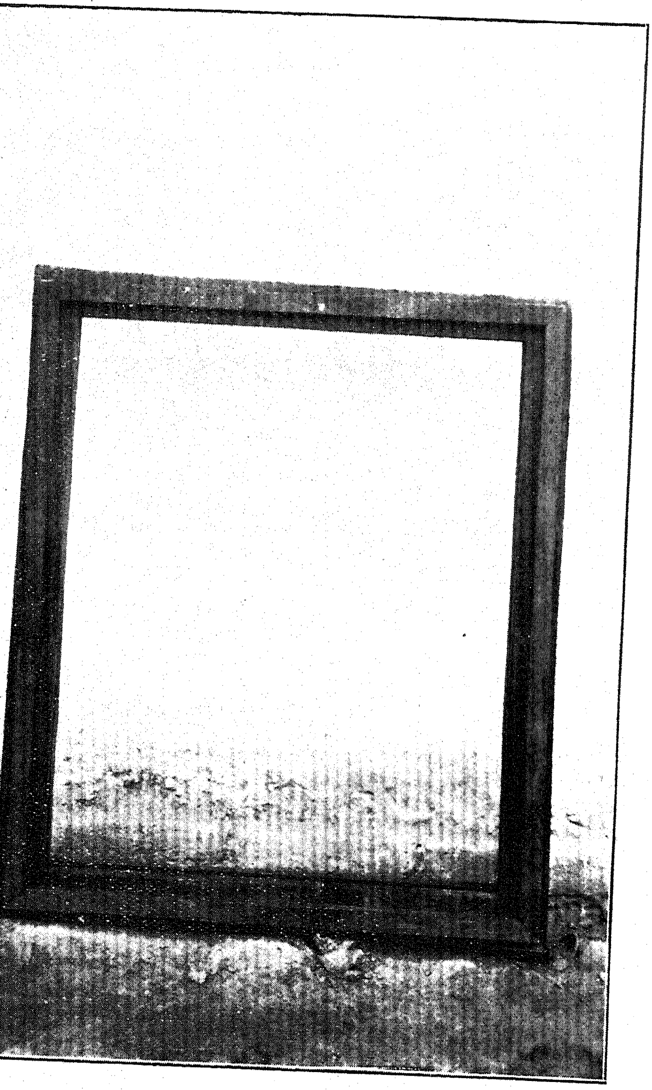
The Wattle Silo.—As the demand for silage was increasing with the growth of the Pusa milch herd, it occurred to the writer to construct a silo having the proper shape and dimensions but constructed of such materials that its cost could easily come within the means of zemindars and the more wealthy cultivators, but which might also be a cheaper means of storing fodder against years of scarcity for the Agricultural and Military Departments. The material selected was, therefore, of the cheapest. It consisted of bamboo wattle covered over with a plastering of mud and a light roof of thatch. The size is 24 feet high by 18 feet diameter. At intervals of 6 feet, windows $3' \times 2'$ are let into the wattle, the top window being cut into the roof and provided with a weather-roof. (Plate XI.) The construction was extremely simple. Bamboos were planted in the ground 3 or 4 feet apart in a circle 9 feet diameter, and split bamboos were wattled between these bamboos. (Plate XII.) When the desired height was reached (in this case 24 feet), 4 posts made by splitting two palmyra palm trees each into half, were planted 6 feet in the ground and lashed with rope or wire against the wattling at equal distances apart. This stiffened the whole structure and prevented bulging or falling over. The windows were next put in. This is not an easy matter when

PLATE XII.



A. J. I. SILO-WATTLE COMPLETE AND WINDOWS PUT IN.

PLATE XIII



I. WINDOW OF SILO (*from inside*) SHOWING GROOVE.

dealing with wattle. Before the space for the window was cut, two frames of the size of each window, of 3″ × 1″ board were first made ready. One of these frames was placed inside the silo, the other outside in such a way that they exactly coincided with each other. When in this position, they were firmly bolted together with 4 or 6 screw bolts, the wattle being between the two frames. The next operation was simple ; with a hand saw the bamboo wattle that came within the frames was cut away and a firm well set window was the result. (Plate XIII.) In this way, the bottom and middle windows were inserted 6 feet apart. This distance, being about equal to the height of a man, is suitable when unloading the silo. In order to close the window a flap made of one inch board is provided. This fits into a groove made in the inner frame of the window, and is kept in position by a bamboo outside tied to an iron staple in the centre of the flap and twisted till it catches firmly against the window frame. (Plate XIV.) When the silo is filled, the flap will keep its place from the pressure inside. In order to prevent air getting in at the sides of the flap, the groove should be well puttied before the flap is put in. The top opening is made by cutting into the roof and fixing a weather-roof over it. It is necessary to have an opening above the height of the silo in order that it may become filled to the brim and that the full capacity of the silo may be utilised. The roof itself is of the simplest kind and is made with a light thatch. The structure having been completed, the whole is plastered with mud both inside and out and left to dry for a few days, after which it may be filled.

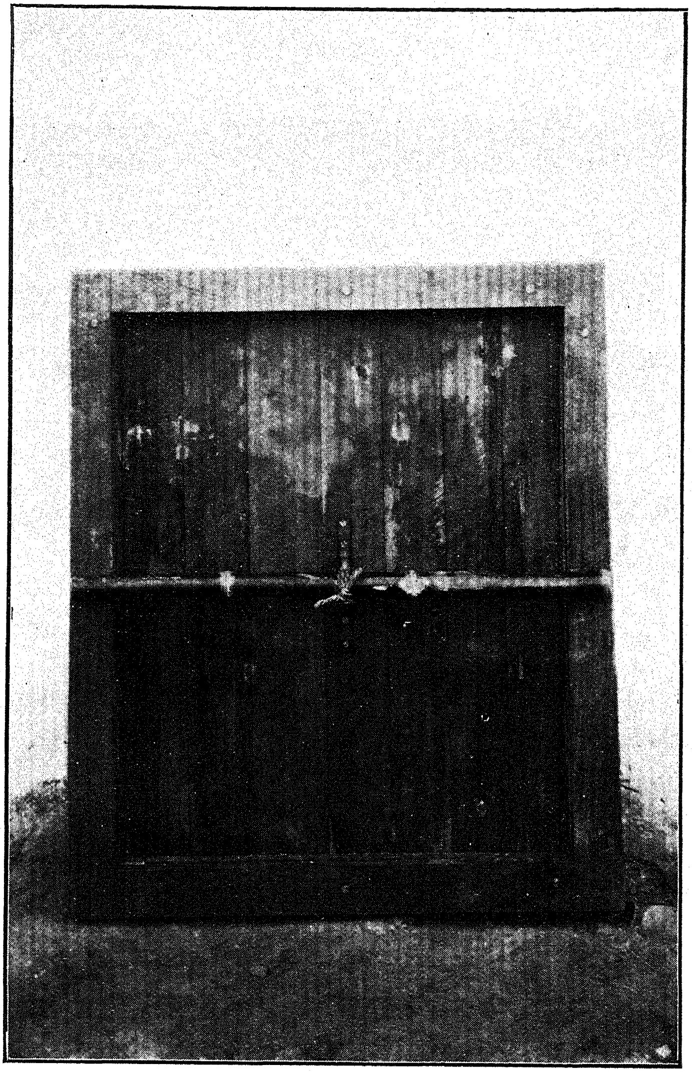
Cost of Construction.—The cost of construction is small, but will vary with circumstances. Thus a zemindar or cultivator to whom the materials are available for next to nothing could put up a silo such as I have described for from Rs. 50 to Rs. 100. For others, such as farms belonging to the Agricultural or Military Departments, it might cost from Rs. 150 to Rs. 200, according to the cost of labour and materials. The silo depicted in this article cost at Pusa Rs. 166, of which exactly half was the cost of

material and the other half of the labour. The fact that it was being constructed experimentally and the labour paid for by the day, permits of the belief that with the knowledge of the details of construction acquired, it would cost very much less if given out on contract.

Filling the Silo.—The filling of the silo may be done in two ways. The material may be chaffed and lifted with baskets by coolies as depicted in Plate XV, beginning with the lower window, or an elevator may be attached to the chaff-cutter and the material raised automatically into the silo as depicted in Plate XVI. It should, however, be observed that the elevator should be longer than that in the picture and be able to reach the top of the silo. As the chaff is delivered into the silo either by the elevator or the baskets, men should be inside in order to spread the chaff and enable it to settle evenly. The more uniform the packing throughout, the better will be the preservation of the silage. The material should fill the silo above the brim. In a few days it will sink some four or perhaps five feet, when it should be filled up again and the operation repeated until sinking has ceased. Rapidity of filling does not, on the whole, appear to be important, but it is desirable that the material should be fresh. To cut maize or sorghum one day and place it into the silo the next is not to be recommended. It should be placed in the silo the same day it is cut.

Crops for Siloing.—In the opinion of the writer, the best crops for siloing are either maize or sorghum. Other crops, such as millets, lucerne, grasses, etc., will make good silage, but the outturn obtained from these per acre is so small that they could not be considered the most economical. On the other hand, 200 to 300 maunds of maize and 400 to 600 maunds of sorghum can, without difficulty, be obtained per acre. In the case of well-manured fields, such as municipal lands, I have known very much higher yields being obtained. These heavy returns are not so easily obtainable with maize as with sorghum as it is a crop which has to be spaced in order to grow well; no spacing, however, is necessary for sorghum. An advantage which maize has over

PLATE XIV.



A. J. I. WINDOW OF SILO CLOSED (*from outside*).

A. J. I.

SILO BEING FILLED BY COOLIES.

sorghum is that it is m… nutritious if the cobs are allowed to get to the milk or dough stage, but it is doubtful whether this extra …n from its nutritiousness can compensate for the large yield acre which can be had with sorghum.

Silo's Capacity.—The capacity of the silo described in this … is 6,096 cubic feet, but inasmuch as the contents will sink, the actual net capacity is considerably less. If, however, the silo is refilled after sinking as recommended in this article, 6,000 cubic feet may be taken as its greatest capacity. The weight of a cubic foot of settled silage varies with the depth of the silo and the part from which it is taken, but it may be taken as from 30 to 50 pounds, or say an average of 40lbs. per cubic foot. The contents of the silo would, therefore, be 240,000lbs. or 3,000 maunds if filled to its greatest capacity. From these figures, it should be easy to calculate the time such a silo would feed a given herd of Indian cattle for a given time. Let us suppose the daily allowance per head to be 30lbs. of silage, it would be possible to feed with it 8,000 head of cattle for one day or 44 head for six months. This calculation is made for full-grown animals. In a mixed herd of big and small, it may be taken as being able to feed twice that number.

Advantages of Silos.—The benefits from the siloing of green crops are many, but the following may be especially mentioned :—(1) Crops may be cut in any weather, unlike the making of hay or harvesting of corn which requires fine weather. (2) Crops can be stored and preserved in a green and succulent condition throughout the year and even longer. (3) Siloing is economical as it enables one to cut during the monsoon crops yielding very heavy returns per acre, such as sorghum and maize, and thus avoid the expensive practice of having to feed light winter crops such as lucerne, green oats, etc., giving but a small return per acre. (4) The bamboo silo described in this article is cheap considering its capacity and could well be made an easy means of storing fodder for times of scarcity, the cost of construction being only one-half anna per cubic foot of capacity.

nprovements.—It may be necessary to warn readers that
) depicted in this article is not expected to last like a brick
den silo. What the life of the bamboo silo is, is a matter
periment. The simplest form has, in the first instance,
onstructed in order to ascertain the weak points. These
sure to show themselves in the course of a year, when
e remedies may be applied. It must, however, be
pered that where improvements have to be met out of
outlay, it is not always the most lasting thing which is
st desirable, although in the long run it may be the cheap-
he writer has known of cases where the more permanent
re was a distinct loss. Thus with the interest of the
which was required for erecting a corrugated iron roof,
found possible to put up a new tiled roof every three
though this was not actually necessary, for the latter with
expenditure in yearly repairs could be kept going for
ears. And so it may be with silos. In a country like
here the agriculturist has no capital and a destroying
cheapness in construction is essential. The writer, how-
ticipates that it will probably be necessary to give the
silo a brick foundation so as to prevent rotting at the
This and other matters will be taken up in a future article
perience has been gained.

PLATE XVI.

A. J. I. SILO BEING FILLED WITH AUTOMATIC ELEVATOR.

THE "PAIRI" MANGO.

By WILLIAM BURNS, B.SC. (EDIN.),

Economic Botanist, Bombay.

IN the Bombay markets the mango most in demand is the *Alphonse.* This is a fairly well-known variety and has been distributed to most quarters of India, to the West Indies, to America and to Australia. Next to this famous variety, a much less known variety called the *Pairi*, has a large production and sale. Fig. 1 shows the typical Alphonse fruit, the left shoulder is high, the right low, and the beak is almost absent. In contrast to this Fig. 2 shows a typical *Pairi* fruit. Both shoulders fall about equally, and the beak is very marked. The shapes of both varieties are fairly constant and it is impossible to confound the two, once one has seen them side by side. The *Pairi* fruit when fully ripe has an external colour, varying from red on the shoulder to yellow at the beak. The flesh of this mango is of a brownish orange colour with very little fibre. The stone occupies perhaps one-third of the volume of the fruit. The taste is delicious, and slightly more piquant than that of the Alphonse.

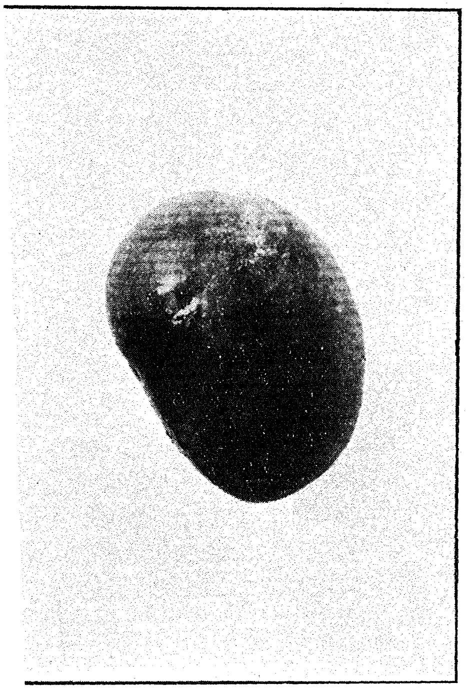
Some judge the taste inferior to that of Alphonse, but personally I prefer the slightly acid *Pairi* to the heavier and more luscious Alphonse. Woodrow gives the following weight and size of a typical fruit—weight 8 ozs., size $4 \times 3 \times 3$ inches. One which I measured and weighed myself was as follows: weight 360 grammes, size $10 \cdot 5 \times 8 \cdot 5 \times 7$ centimeters. It is therefore a moderate sized mango. There are several varieties with bigger and many with smaller fruits. The *Pairi* mango has one defect. It does not keep well. Whereas Alphonse may be kept up to two months even, if properly stored;

airi, with the utmost precautions, will hardly last 8 days. ıis character and its different flavour make it a cheaper mango an the Alphonse. In the Crawford Market, Bombay, when lphonse mangoes are fetching retail round about Rs. 2 a dozen, *airi* mangoes usually fetch only Re. 1-8 a dozen at the outside. ıeir wholesale prices are similarly graded. I have been informed ıt in the season Alphonse will sell wholesale for Rs. 10 to Rs. 15 r 100, while *Pairi* will fetch only Rs. 8 to Rs. 10 per 100. e leaf of the *Pairi* mango is very typical of the variety. It long, tapering, pale green, with a strongly marked white drib. Such a leaf is shown in Fig. 5. (The scale in the figure divided into centimeters.) The *Pairi* mango tree has a most orous spreading habit of growth and this is well shown in ;. 4 where a tree of about twenty years of age is shown. This ıracter of the *Pairi* makes it an excellent trunk piece for a ıposite grafted mango, giving a vigorous stem.

One or two sub-varieties of the *Pairi* mango are known, *Moti Pairi* (Fig. 3), which is a larger kind, one specimen of fruit which I examined weighed 527 grammes and measured ‹ 9·5 × 8 centimeters. Another sub-variety is the *Kagdi ri* (Kagdi-papery) so called on account of its thin and ıing skin. The fruit is said to have firmer flesh and to be ərior in flavour to the ordinary *Pairi*.

As regards the source and history of the *Pairi* mango little ıown, but it is clear that it is of Bombay origin and has been ə cultivated in other parts of India. Maries, in Watt's *ionary of Economic Products*, Vol. V, pp. 146–157, has one ɔtful reference to *Pairi* which is worded as follows :—"I ıld advise planting seedling mangoes where grafts are diffi- to obtain taking for the seed only such sorts as *Afooz ry*, Kishenbogh, Durbhangah, Bombay, Fuzlee and good ıs." In the portfolio of paintings of mangoes in the her- ım of the Calcutta Botanic Gardens I found no painting lled Pairi. Firminger in the year 1874 or the more recent on of his *Manual of Gardening for Bengal and Upper a* does not mention the *Pairi*. Two old Indian gardening

PLATE XVII.



I. FIG. 1.—TYPICAL ALPHONSE MANGO.

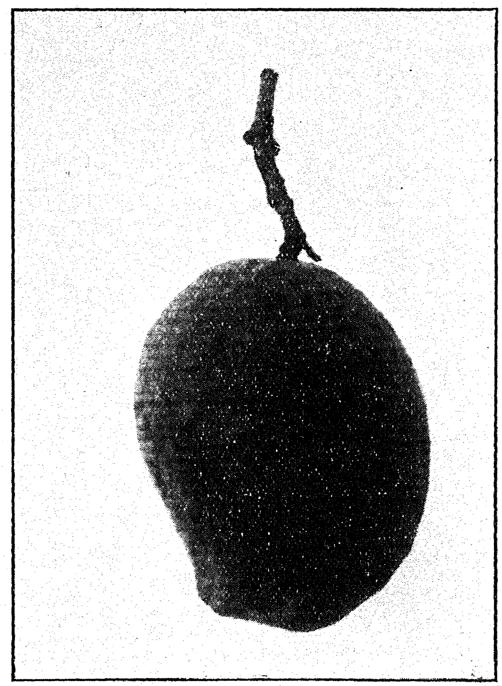


FIG. 2.—TYPICAL PAIRI MANGO.

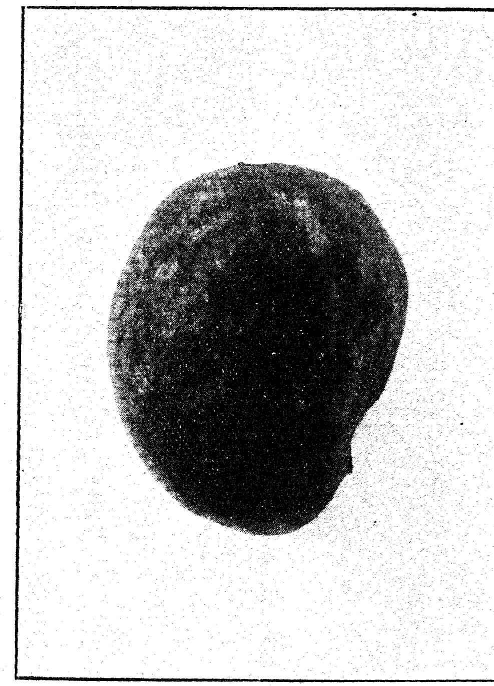


FIG. 3.—MOTI PAIRI MANGO.

Negatives by Dr. Mann, Agricultural College, Poona.

PLATE XVIII.

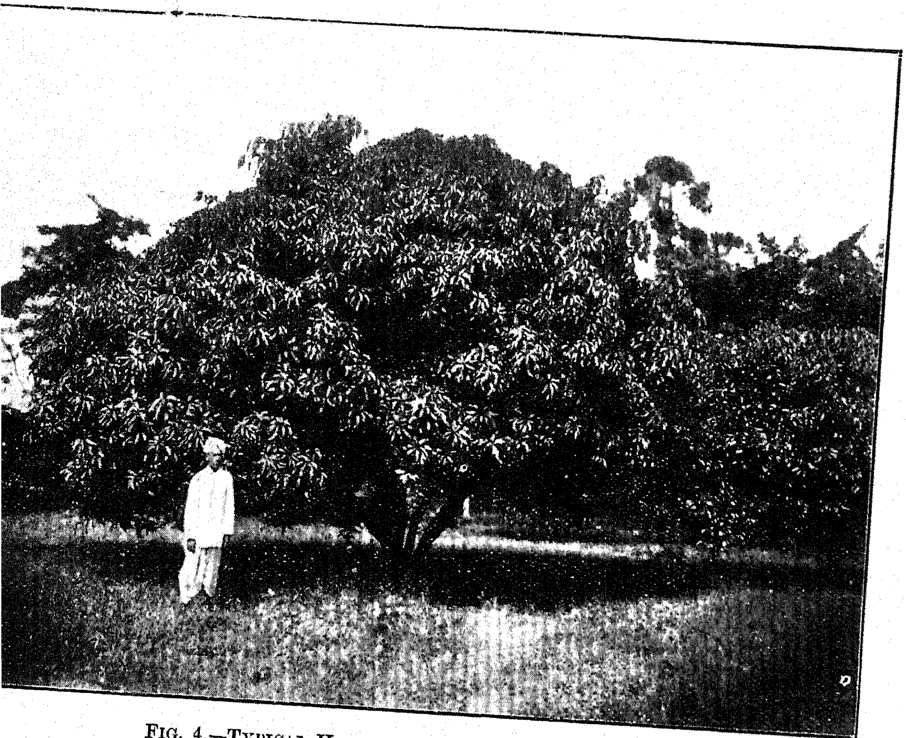


FIG. 4.—TYPICAL HABIT OF PAIRI MANGO TREE.

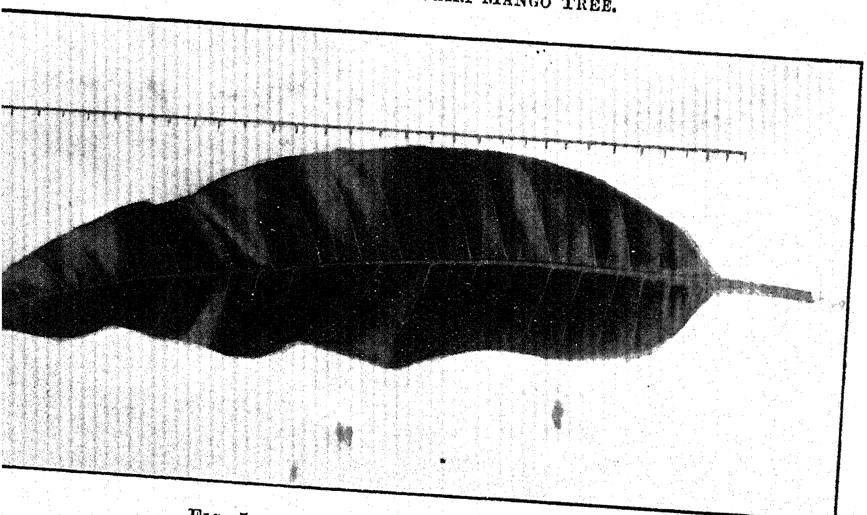


FIG. 5.—LEAF OF PAIRI MANGO.
Negatives by Dr. Mann, Agricultural College, Poona.

books, Speede's *The Indian Handbook of Gardening* (Calcutta, 1842), and Pogson's *Indian Gardening in Bengal, Upper Provinces, and the Hill Stations of India* (Calcutta, 1875), make no mention of *Pairi.* These facts would seem to show it was for long unknown in Upper India.

On the other hand in a Resolution of the Bombay Government, Revenue Department, made in 1885, the following entry is made against Thana, "Afus and Pyre mangoes are largely grown in this District especially in Salsette." Cooke, in his *Flora of the Bombay Presidency*, 1903, Vol. I, p. 214, has a long note on the *Pairi* mango, mentioning its botanical and commercial characters. Gupte and Raje, in their Marathi book, *Krishi Karma*, 1901, p. 680, mention the *Pairi* mango and state that its name is a corruption of the Portuguese name Pereira. This is not impossible seeing that the Portuguese Alphonse has become corrupted into Apoos, Afoos, and Hapoos. In Woodrow's *Gardening in India*, 1894, pp. 253—260, *Pairi* is mentioned as one of the celebrated mango trees occurring in the following districts :—Poona, Kolaba and Surat.

All this would seem to show that it is a mango evolved probably by some Goanese horticulturist, but that it has somehow not spread over India or come to the knowledge of gardeners outside the Bombay Presidency to the extent that Alphonse has.

WHEN SHOULD MANURE BE APPLIED IN INDIA?

BY J. WALTER LEATHER, Ph.D., F.I.C.,

Imperial Agricultural Chemist.

Two principles are acted on in the application of manure: the one being the most advantageous season to put it on the land, the other the most suitable crop to give it to. It is in relation to the former that the following suggestions apply.

Fertilisers, whether soluble in water before being put into the soil or not, must all become soluble before they are of service to the plant. Some, such as the "bulky" manures, farmyard manure, compost, refuse, indigo-seeth, and such like are in part soluble at first, and become more so as decomposition sets in: oil-cakes are similarly placed. Others, such as Indian saltpetre, Chili nitre, or sulphate of ammonia are entirely soluble in water. Superphosphate of lime is soluble in so far as its most important constituent, calcium hydrogen phosphate, "soluble phosphate" is concerned. The finely ground rock phosphates, basic slag or bone-meal are so nearly insoluble in water that they are classed as "insoluble" though it is well known to the agriculturist that they must be so far soluble that they can serve the plant; otherwise they could not play the part they do.

But since such materials must be soluble in order to be useful, it is evident that the amount of water in the soil and the rainfall must have an important relationship to the employment of such materials. This factor has been recognised in Europe, but our Indian agricultural literature is without serious reference to it.

The problem is this. If we have a certain manure to put on the land, does it matter when it is applied, or must we select a

particular month of the year or a particular season for the purpose? This largely depends on whether the material is "soluble" or not, because if it is soluble, heavy rain may wash it away from the region in which the plant-root development is taking place. For example, Aikman in his "Farmyard Manure" (page 43), says :—"As to the depth to which it is advisable to plough the manure in, it may be here noticed that it should not be too deep, so as to permit of the access of sufficient moisture to ensure proper fermentation, and to prevent rapid washing down of nitrates to the drains." And again in his "Manures and Manuring" (page 479), he says; "Nitrate of soda should never be applied before the plant is ready to utilise it" and "the use of such a fertiliser in a damp season is less likely to be economical than in a dry one." Such general principles are well known; the sentences quoted were naturally written for British farmers; they are simply an expression of the necessity for considering the current water supply as well as the nature of the fertiliser.

In India then it is important to apply these principles also. Since the fertiliser has to be brought into the soil at such a depth that it may be at the service of the plant, and yet be not washed away by drainage, consideration of the rainfall is the key to a right solution of the question. We may state it thus:—what rainfall do we require (if any) to wash our manure, or the soluble part of it, into the stratum of soil in which the plant is feeding, and what probability is there of it being carried too far down into the sub-soil?

In Europe the question is answered briefly thus :—bulky manures and oil-cakes should usually be ploughed into the land before the crop is sown, though some people put farmyard manure on the surface after the crop has germinated (*i.e.*, it is not ploughed in at all). Similarly the "insoluble" fertilisers such as basic slag or superphosphate are ploughed into the soil before sowing; but the very soluble materials like the saltpetre or sulphate of ammonia are more commonly broadcasted on the land after the crop has germinated; indeed when a crop is sown in the autumn such materials are not put on the land until

the spring time because during the winter, plant growth is very slow and fertilisers are more useful in the spring time when growth is rapid.

This practice is based on the general rainfall. Broadly speaking this is distributed uniformly over the whole year; each month receives its quota, rarely less than 1 inch, generally more. One inch of rainfall if it falls mostly within a few days in Europe is ample to wash a soluble manure well into the soil. It is probable that drainage would occur, but the fertiliser is not necessarily carried into the drains. When rain falls, for the most part it merely displaces water already in the soil (assuming no drought to have occurred) and some of the *latter* water finds its way into the drains. Even 2 inches of rain, falling within a few days, would not itself pass further than 12 inches deep, and in most cases it would reach a less depth than this. Hence it follows that in Britain it is quite safe to apply soluble manures, and even farm manure as a "top-dressing." Whether it would be equally good practice to put the former into the soil before sowing is another matter. Other considerations play a part. Not merely do we desire to prevent such materials from passing away in drainage water; we must recollect that they may be lost to the plant in other ways, such as by bacterial changes. The latter simply make it generally desirable to present soluble manures to the plant as nearly as possible when the plant can use them.

It becomes then a question to consider in how far our Indian rainfall will indicate the most suitable mode of applying fertilisers. It will be most convenient to take the case of saltpetre first, because it is entirely soluble to start with, and will be carried with any water that happens to be present. Considering the two great divisions of crops, *rabi* and *kharif*, it is generally assumed that if saltpetre were used for the *kharif* it would be washed away before the crop could use it. Of the *possibility* of this happening there can be little doubt. For the sake of example I will consider the part of India where I reside—Behar. On the average between 5 and 10 inches fall in June mostly in the latter part, in July the mean fall is between 10 and 15 inches. Now at the

close of the hot weather, and assuming the land to have been already ploughed a single fall of 5 inches would be all taken up by the soil and would distribute itself largely in the first and second or first to third feet. Under such circumstances it would be a mistake to put saltpetre on the land before the first rain. But the general practice is to cultivate the land during the first break succeeding the first fall of rain when the soil is nicely moist without being too wet and seed is sown on this. Supposing then that saltpetre were used at this time and 5 inches of rain fell some time in the next fortnight, it would be sufficient to displace the whole of the water in the first foot, and since this displacement is not perfect, some of it would find its way, may be, into the second foot. In this case also the fertiliser would be carried beyond the stratum in which the young plant wanted it, unless, indeed, the latter had developed unusually fast. On the whole, it would be an unsafe practice to sow saltpetre with the seed. But supposing the crop is allowed to grow, say, 6 or 8 inches high and the saltpetre is then put on, it is improbable that it would be carried beyond the stratum in which we require it. The root development will have extended beyond the first foot, the crop transpires at this stage probably 2 to 5 lbs. of water per sq. foot per day (·4″ to 1·0″), and unless the fall of rain succeeding the application of saltpetre were unusually heavy, such as 10″ on one day, or say even during three succeeding days, the fertiliser would be where the plant required it. I have assumed rather extremes throughout in order to show what both the possibilities as also the probabilities of the case are. Nor have I instanced the use of saltpetre as a top-dressing for a young crop in July in order to *recommend* it; it is probably more suitable for another season, but there would be no risk of the manure being washed away out of the area of the root range. So far as I can tell from my soil moisture records at present, "top-dressing" with saltpetre in Behar in July would be successful in most years.

We may also consider the case of Cawnpore. This soil holds probably about as much water as the Behar soil does. Th

following is a statement showing the fortnightly rainfall in the second half of June and the month of July for the last nine years; and an inspection of it indicates what the probabilities are of a soluble fertiliser like saltpetre being carried by heavy rain out of the reach of a young crop. In two years, 1904 and 1899, this risk would have been serious; but in the remaining eight years such a manure might have been safely used as a top-dressing.

Cawnpore.	June 15th to 30th.	July	
		1st to 15th.	16th to 31st.
1906	6·55	4·76	2·21
1905	......	5·62	2·52
1904	3·77	5·67	11·13
1903	1·72	......	0·77
1902	......	2·45	4·57
1901	......	4·66	2·99
1900	1·16	2·67	2·50
1899	5·50	4·85	15·52
1898	2·09	3·85	5·67
1897	1·20	0·94	5·02

We may turn to another example, namely, Dehra Dun. There the soil is generally stony, and although there are some areas of stiff land, the greater part would certainly not hold, per cubic foot, nearly so much water as the Behar soil; most of it would not hold more than half as much. Consequently any particular rainfall would displace water to a much greater depth than in Behar, and soluble fertilisers would pass correspondingly deeper. Add to this the fact that the rainfall is considerably heavier, and it becomes clear that in most years such fertilisers could not there be employed profitably to a rains crop.

We may next turn to the *rabi* season as exemplifying a rainfall characteristically different from the *kharif*. There is a general belief that such soluble fertilisers as saltpetre may be most economically applied to the cold weather crops. Such a belief is possibly sound. The average rainfall over nearly the whole of India from October to April is only a few inches and is generally insufficient to cause drainage; part of Eastern

Bengal and Burma forming perhaps the only exception. Consequently the risk of loss of such soluble plant food from this cause is nominal.

The question then follows whether the fertilisers should be ploughed into the land before sowing the crop or be put on as a "top-dressing." Taking Behar again as an example, the monsoon proper is expected to continue well into September and drainage does not usually cease until the end of that month. During October anything from 2 to 5 inches may be expected falling on an average of 2 to 5 days, that is, it is commonly fairly good rain. November and December are usually rainless. It follows, therefore, that if manures are to be used at all, they must be applied in October, and it seems clear that the proper course to pursue would be to plough them in with the last ploughing before the seed is sown. Top-dressing would in most years be useless, for the manure would remain on the surface, or at least diffuse into the soil only slowly.

Turning to Dehra Dun again the circumstances are different. October has its showers usually like October in Behar, but the temperature is so much lower during November and December that crops are held back and they mature fully a month later than in Behar. In addition to this there is nearly always some rain at the end of December or in January and fertilisers which had been put on the growing crop immediately prior to these rains would be sufficiently well washed into the soil to enable them to play the part they do in Britain. Thus, top-dressing for the *rabi* crop in Dehra Dun would generally be successful.

Another suitable example is the black cotton soil area in the Berars, taking Akola as a specific point. The land is "black cotton" soil and this will usually hold a fairly large *maximum* amount of water. The rainfall of this part is only small, *viz.*, about 30 inches; and this is distributed very uniformly over June, July, August and September; usually less than one inch falls in any of the other eight months of the year. Clearly then we may say it is useless to put a soluble manure on the land as a top-dressing during the "

would be necessary to plough it in before sowing. For the "rains" crops it is probable that it would be unsafe to put it on the land before sowing. It is true that when rain comes at the end of the hot weather the land will be so dry that the five or six inches of rain will be absorbed mostly by the upper foot of soil, but black cotton soil cracks so much that some portion of any heavy rain runs directly into the subsoil, and whilst an exaggerated idea exists regarding manures being washed away by rain, still in the case under consideration there would be a risk of some loss. On the other hand, if a soluble manure were scattered on the land after the crop had grown six inches or so high, the current rainfall of July should wash it into the soil; the hot weather cracks will be closed up by this time, and the usual rainfall would not be sufficient to carry the fertiliser out of the area in which the root development is taking place. Even a fall of two inches of rain at one time would do no harm in this respect, though one of four inches in one day might do so.

On the other hand, the same assurance could not be given for the neighbourhood of Nagpur where the soil is also "Regur." Appended are the rainfall data for the latter half of June and the month of July, and judging from this it seems likely that in six out of the nine years top-dressed saltpetre would have been largely lost to the crop.

Year.	June 15th to 30th.	July	
		1st to 15th.	16th to 31st.
1906	17·37	4·79	9·85
1905	5·1	9·79	2·50
1904	6·3	3·90	0·57
1903	5·62	7·25	17·52
1902	0·10	8·36	2·28
1901	4·84	1·04	6·92
1900	2·74	7·61	7·84
1899	4·00	1·68	1·56
1898	3·00	6·54	12·99

So far then as these very soluble fertilisers are concerned, it is purely a question of probable rainfall together with a consideration of the maximum amount of water the particular soil will hold.

I have been asked two questions in relation to possible loss of soluble fertilisers. The first is, supposing after *top-dressing* with say saltpetre, a heavy fall of rain commences, such as $\cdot 2''$ in the first hour, would any of the fertilisers be washed off the land? It is easy to show that it would not. We may take the following figures by way of illustration. Assume that the top-dressing has consisted of 500lbs. of saltpetre per acre; this is a much larger amount than one could usually afford to put on for a crop, but an extreme figure is purposely taken. Previous to this rainfall it is to be assumed that no rain has fallen for at least some days; otherwise the "top-dressing" would hardly have been put on. Since a young crop transpires very large amounts of water, it is clear that the surface soil cannot be saturated; hence it is equally certain that the first rain will soak into the land; it will be sufficient to assume that the first $\cdot 2''$ is thus absorbed before any water commences to run off by surface drainage. Now 500lbs. per acre is equal to ·18 oz. per sq. ft.; $\cdot 2''$ of water = 16 oz. per sq. ft., and since the 18 oz. of saltpetre would readily dissolve in $\frac{3}{4}$ oz. of water, it is clear that the first $\cdot 2''$ of rain (16 oz. per sq. ft.) is far more than is required to dissolve up the fertiliser; this water is indeed sufficient to carry the solution at least $\frac{1}{2}''$ below the surface. If it is further recognised that there must be a downward movement of water taking place in the surface soil throughout the duration of the rainfall we are considering, it is clear that the nitrate having once entered the soil, it is perfectly protected from removal in any of the rain which may subsequently run off the field.

The second question which my friend put is in relation to "diffusion." I am not sure that the general reader of this journal will understand what this process is, but he may readily make an experiment which will demonstrate it to himself. Take a small teaspoonful of sugar in a glass tumbler and add ten tea spoonfuls of water. If the sugar and water are stirred together, the former will gradually disappear and *dissolve* in the water. We shall then have a solution of sugar. Now pour on to the top of this solution

the tumbler is nearly full. The water must be poured down the side of the tumbler very slowly and carefully so that it does not mix with the sugar solution any more than can be avoided. Now place the tumbler on a shelf where it won't be disturbed. At first the sugar solution will appear quite distinct from the water above it, but gradually in a few days it will be seen that the one liquid merges into the other and that the water in the upper part of the tumbler will become sweet. Thus the sugar has passed without any shaking or stirring from the one water into the other. This process is called "diffusion" and it occurs whenever a solution of a substance is brought into contact with some more of the same solvent.

Now the question which was put to me in relation to the possible removal of soluble manure, was this. Assume that the saltpetre is ploughed into the land before sowing, and that subsequently moderate though not excessive rain occurs, sufficient to carry the salt from the top 4″ of ploughed soil more or less into the first 12″. We would now have a solution of saltpetre in the first foot, but in the second and succeeding feet we should have either less or no saltpetre (there would probably be some saltpetre in the subsoil independently of that ploughed in). Diffusion would now naturally set in, and occasion some of the saltpetre to pass into the subsoil. My friend's question then is, would this process of diffusion be likely to occasion the removal of so much of the saltpetre from the surface soil to the subsoil and hence from the area in which the growing plant is developing as to seriously rob it? The information on the subject of diffusion of salts in soils is very limited, but it is a very much slower process than in plain liquids and I shall be safe in saying that not one-tenth part of the saltpetre could be thus lost to the plant.

Passing from these very soluble fertilisers to the insoluble ones such as finely ground bone, mineral phosphate, basic slag, it is clear that since they are so little soluble in water, they cannot be washed into the soil like sulphate of ammonia or saltpetre by heavy rainfall. The chief point to bear in mind in their use is that they should be as intimately mixed into the

soil as possible. Accordingly it is an advantage to broadcast these fertilisers on the land at the commencement of tillage operations and give them every chance, by the repeated ploughings and cultivations that precede sowing, of becoming thoroughly incorporated into the soil.

Superphosphate, in so far as it is affected by rainfall, stands on much the same footing as insoluble fertilisers. Its chief constituents, the soluble phosphate of lime, is, as a matter of fact, perfectly soluble in water, but no sooner does a solution of this substance come in contact with the lime and iron in the soil, than it is rendered again insoluble and it is caught, so to speak, by the soil. Were it not for one factor it would be best to deal with it like the bone meal or basic slag, and bring it into as perfect intermixture with the soil by tillage operations as possible. But it is expensive, especially in India at present, and on this account a distinct advantage would lie in "drilling" it into the land immediately in front of the seed. It would then be carried by rain into just those parts of the soil where the young plant develops. Of course in many parts of India seed is not drilled but only broadcasted, and in such parts superphosphate also cannot be drilled.

The third great class of fertilisers are the bulky manures. There can be no object in making suggestions to practical men about the application of these. It is known from experience that they must be mixed into the surface soil some little time before sowing the seed where they become gradually changed into substances which the plant can assimilate. It may be of interest to some readers of this Journal to know that one part of such fertilisers is changed into the very soluble nitrate which we dealt with previously, and this can of course be carried away by drainage water. On the other hand, this nitrate is formed *gradually* and hence if a heavy rainfall occurs shortly after ploughing-in farm manure or a green crop, only that part of the nitrate which has already formed can be removed; a further part will be formed later on as the season progresses and some no inconsiderable part is reserved in the soil for future years.

THE PRESENT POSITION AND PROSPECTS OF COTTON CULTIVATION IN INDIA.—II.

(PRESENTED TO THE BRUSSELS CONGRESS, MAY 1910.)

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(*Continued from page* 351, *Vol. V, Pt. IV.*)

II.—THE SPECIAL DIFFICULTIES MET WITH.

MR. MOLLISON, Inspector-General of Agriculture in India, wrote two valuable notes on the improvement of cotton, one in 1902 and the second in the year following. To understand these properly it should be remembered that all previous attempts to improve the standard of cotton in India had been framed with the idea that there was no possibility of permanent improvement of any indigenous variety and that success could only be looked for in the introduction of some exotic already possessing the characteristics required. A renewed study of the problem thus brought prominently into view two main features, firstly, that there was not full information on record regarding the agricultural characteristics and comparative values of indigenous varieties, and secondly, that unsuccessful efforts have been made for many years to induce the Indian cultivator to grow exotics in order that finer lint would be produced.

In 1902 and succeeding years samples of indigenous cotton seeds bearing different vernacular names were obtained from all the provinces of India for sowing at Poona and other centres, and this collection in time formed a complete representation of the many types of cotton grown in the country.

A classification of these was attempted by the present Cotton Specialist. This was accepted as a handbook suited to the requirements of field-workers by most of the provinces of India, especially as it essayed no violent departure from any of the usually accepted methods of classification, its only novel feature being that it emphasised the necessity of subordinating botanical requirement to agricultural needs in the account of an Indian genus so highly domesticated that it is difficult to assert that any form exists in a truly wild condition in the country.

Having obtained a clear idea of the botanical characteristics of the cotton plant in India, the next steps were to judge of their comparative values from an agricultural point of view by seeing them grow side by side under varying conditions of soil and climate, and to determine how far the characters of a variety change by moving it from one district to another. The study of these questions in their entirety is obviously one that can only be completed after many years' observation, but by co-ordinating results obtained on the experimental farms throughout India, the following salient facts are more or less established :—

1. That long season cottons are quite unsuitable for early season cotton districts and *vice versâ*, and that slight differences of climate cause large differences in the quality of cotton produced.

2. That varieties characteristic of the black cotton soil fall away in some inherent quality if transferred to another class of soil.

3. That exotic varieties thrive better in red or sandy soils and have thus only been introduced permanently with varying degrees of success, outside the regular superior Indian cotton areas, *e.g.*, Dharwar American, Bourbon in Coimbatore, North Gujarat and the Konkan ; Egyptian in Sind ; Upland Georgian in the Punjab and United Provinces.

4. That inferior varieties are in many tracts ousting superior chiefly on account of their greater hardiness and more certain yield of a large outturn of cotton, and that the so-called deterioration of Indian cotton is really due to this *plus* the fraudulent practice of middlemen.

5. Good varieties from the first, when isolated, are superior to the remaining members of the general mixture too often found growing in the fields, *e.g.*, *Malvensis* in the Central Provinces and Khandesh and *Karungani* in Madras.

6. That, in rare cases, provided conditions are similar, a superior variety of the same type can be substituted with advantage, for instance, Broach cotton for *Kumpta* in the Dharwar District of Bombay.

7. That cross fertilization *inter se* has in many cases undoubtedly strengthened the stock, but the same method employed between different varieties has, up to the present, yielded nothing of permanent advantage. The reason for this can be gathered from the final paragraph.

8. In conclusion, the cotton plant is so influenced by its environment that in some provinces, for instance, in Gujarat, varieties which appear to be absolutely the same in every way from a botanical point of view have, nevertheless, individual characteristics which allow them to be grown in perfection and with profit only in the tracts where they have become the actual children of the soil.

As regards the chance of acclimatising exotics from which alone we can hope to produce cottons of sufficient merit to compete on equal grounds with that of America and Egypt, it is interesting to observe that Mr. Mollison's surmise (which is given in the next sentence) was practically sound and still holds good after seven years' further experience. He said: "Certain exotic cottons can, I am sure, be much more successfully grown in the alluvial plains of Upper India with canal irrigation than in the black cotton soil areas in Madras, Bombay, Berar and the Central Provinces; and any real improvement of cotton in these black cotton soils can only be obtained *by working from within.*"

For many years past it has been considered that the problem of how to produce a high class long stapled cotton in India could be solved by the cultivation of one or other of the many foreign and naturalised varieties of Tree Cotton. In the time of the East India Company strenuous efforts were made in several parts

of the Madras and Bombay Presidencies to establish Bourbon as a crop. Many experiments were made, some showed distinct indications of success at first, but all were in the end disappointing and now the plant exists as a mixture in fields in the red soil of Coimbatore and adjoining districts, and sporadic plants occur in many gardens throughout India and Burma. There is still room to hope that, with more careful selections of locality and the more progressive methods of treatment and cultivation, this variety may yet be found profitable to grow. Trials with Brazilian, Rough Peruvian and a few others have failed completely. The chief objections to the introduction of a tree cotton as a field crop are its urgent water requirement during the early part of its life which, of course, necessitates irrigation over the greater part of India; the extreme likelihood of no crop being produced in the first year; the risk of the very brittle branches being broken by the wind; the increased danger from insect pests which are harboured and carried on from year to year; the imperfect opening of the boll—a condition usually associated with a damaged state of the cotton; and last, but by no means least, a low outturn throughout (as compared with that of indigenous varieties) or a fairly high outturn in the first year followed by steadily decreasing yields in succeeding years.

The greatest difficulty in the way of maintaining superior variety indefinitely, however, lies in the vicissitudes of the seasons. The greater part of the cotton tracts in India is certainly liable to recurring periods of famine. During these, the coarser types which are most resistent to drought, will usually yield something of a crop to the cultivators, while the finer may be hopelessly lost. In succeeding years the farmers, benefiting by a lesson gained through hard experience, carefully sow their fields with seeds derived from the surviving varieties. They may earn less than formerly from the produce of the cotton, but on the other hand, they are more certain of saving themselves from absolute loss. To give instances, the substitution of *Jari* for *Bani* and *Varadi* for *Jari* in the Central Provinces, and of *Mathio* for *Lalio* in Kathiawar, can be accounted for in this way.

Taking, as we perforce must, the climates and soils of India as they are and assuming that the whole area suitable for indigenous cotton cultivation is almost wholly occupied and that exotic cottons (with rare exceptions) have failed to maintain their footing in these, the outcome of a long grapple with difficulties leaves us, at the present moment, equipped with a slender amount of valuable experience which can be shortly summarised as follows:—In the indigenous cotton areas, as Mr. Mollison enunciated years ago, *improvement must come from within.* The results already arrived at in Bombay, Madras, and the Central Provinces teach us that much can be effected in a short period by following up this line alone. In the Punjab, United Provinces, Bengal, and on the lighter soils and heavier rainfall tracts of Madras, Bombay, the Central Provinces and similar regions throughout India, much might still be done in the introduction of one or other form of Upland Georgian if the officers of the Department could only contrive to devote a small portion of their well filled time to the working out of the problem.

III.—The Nature of Experimental Work in Progress.

In the Bombay Presidency experiments have been conducted for several years past to test the suitability of the following cottons in the various cotton areas; Uplands, Cambodias, Buri, Tree cottons, indigenous cottons and hybrid cottons.

After extended trials it has been definitely proved that cottons of the Upland American type only thrive in a certain tract of the Southern Maratha Country at the southern termination of the Presidency. As the land at Dharwar was outside the most suitable tract, a piece of land has been obtained near the town of Gadag, and all serious work on the most promising American cottons was carried through there since last year. At Dharwar, when dry easterly winds blow in the month of December, the plants become badly affected with "red-leaf blight;" at Gadag, it is satisfactory to learn that not even a trace of the disease was visible. The following comparative statement

shows the valuations of the special American cottons cultivated at Gadag :—

Register No.	Name.	Ginning percentage.		Valuation in Rs. per candy of 784 lbs.		Remarks.
		Grown at Dharwar.	Grown at Gadag.	Grown at Dharwar.	Grown at Gadag.	
				Rs.	Rs.	
...	New Boyd's Prolific (manured).	..	38·95	...	257	Equal to Dharwar American.
...	New Boyd's Prolific (unmanured).	...	36·6	...	...	......
...	New Allen's Long Staple (manured).	...	38·49	...	273	Much superior in class and staple to Dharwar American.
...	New Allen's Long Staple (unmanured).	...	37·28	...	...	......
212E	Old Boyd's Prolific.	32·41	36·84	270	259	Dharwar—Much the same as No. 38E-BI. Gadag rather better than Dharwar American.
209E	King's Improved...	33·14	35·38	...	...	.....
211E	Allen's Hybrid ...	33·10	35·03	300 nominal	270	Dharwar—Long, silky staple, the best of the bunch. Gadag—Staple much better than Dharwar American.
207E	Truitt	32·90	35·03	...	257	Quite equal to Dharwar American. Disappointing in staple and colour.
213E	Tata's Allen's Hybrid.	31·03	33·06	..	...	......
38E-BI	New Orleans ...	29·80	32·56	270	259	Dharwar—Nice staple and good staple, but leafy.
...	Dharwar American	...	30·84	240	257	.....

Note I.—The value of good saw-ginned Dharwar, *i.e.*, the best class of this cotton free from any admixture, was worth fully Rs. 260 to Rs. 262.

Note II.—The samples valued were not from selected plants, but were of the general picking.

Note III.—Valuations received through the Imperial Cotton Specialist attribute a higher relative value to the last mentioned cotton in the above list grown at Gadag by about Rs. 13.

The appearance in the fields of all these Uplands shows conclusively that they are just as suited to the climate and soil as the long established Dharwar American, and it is to be hoped that the Agricultural Department will spare no pains to test them to the utmost on an extended field scale before finally arranging for an annual distribution of

A form of Upland Georgian, received from Cochin China, and passing current under the name of Cambodia, has already given clear promise of a greater adaptability to varied conditions as it is immune from "red-leaf blight" even on the Dharwar farm, and its behaviour on a site selected in the more rainy and hilly western part of the Dharwar District goes far to show that it may succeed even there. This year it is contemplated to test it on tracts with a heavy rainfall to fully test its capability. At Poona, in the Deccan, under a rainfall of about 25 inches it has attained maximum growth with produce satisfactory in quantity and quality.

At present the following valuations have been obtained—see page 47.

At Surat Mr. Main says that Cambodia has been found to be the only exotic annual which gives any promise of successfully competing with Broach Deshi in Southern Gujarat. It yields up to 385 lbs. of seed cotton per acre with a ginning percentage of 40. At Dhulia in Khandesh, while the yield of Cambodia was only moderate, its cotton was valued nearly equal to that of Navasari.

Another cotton, very closely allied to this, introduced from Chutia Nagpur in Bengal, where it is known as *Buri*, also yielded fairly good results, but it must be admitted that it is decidedly more particular in its requirements, of which a higher rainfall may rank as being the most called for. In the Central Provinces it has attained distinction in *Bani* growing tracts where the rainfall of the last two years has proved sufficient for it, but in the Bombay Presidency it will certainly have to yield the premier position to Cambodia. At Dhulia in Khandesh and at Poona in the Deccan, its cotton has been valued as equal to Broach which is slightly inferior to that of Navasari.

Tree Cottons.—Many forms of these have been grown in the Bombay Presidency for years and the final consensus of opinion seems to be that the only two at all likely to be profitable are Bourbon and Soft Peruvian. They are both quite hardy, more or less immune to insect and fungoid attacks, but share equally in the drawback of requiring irrigation to tide them over dry

Register No.	Name of variety.	Yield in lbs. of seed cotton per acre.		Ginning percentage.		Valuation.		Remarks.
		Dharwar.	Gadag.	Dharwar.	Gadag.	Dharwar.	Gadag.	
						Rs.	Rs.	
53E	Cambodia from the Philippine Islands ...	276	165	34·58	36·62	...	...	Not valued.
66E	Indo-China ...	418	110	33·75	36·94	...	...	Not valued.
67E	Indo-China ...	545	130	35·89	37·25	270	260	Dharwar—Much the same as New Orleans (ante). Gadag—Rather better in staple than Dharwar American.
68E	Indo-China ...	375	{ 116 / 90 }	35·40	{ 36·83 / 35·20 }	...	...	......
102E	Cambodia from Madras ...	524	70	38·43	39·28	...	...	......
......	Bengal Buri Cotton ...	228	165	31·09	33·66	280	...	Dharwar—Nice strong staple not so long as Allen's Hybrid (ante), but class better, and cotton has more bulk. Gadag—Not valued.

The first figures show the results on a manured plot, while the second refer to an unmanured plot.

Note.—The valuations received through the Imperial Cotton Specialist assign a higher relative value to No. 67E grown at Dharwar by)out Rs. 15.

periods. In the light sandy soils of northern Gujarat they yield a moderate crop in the first season ; over the greater part of the Deccan in the black soil country no return can be looked for until the second year. At the Guneshkhind Botanical Garden near Poona, Bourbon does not yield any cotton in the first season. In three succeeding years the yield was about 100 lbs. per acre valued at Rs. 300 per candy of 784 lbs., or equal to F. G. Navasari. This was from seed produced by acclimatised Deccan plants. Plants grown from seed obtained from northern Gujarat gave cotton which was valued at Rs. 25 per candy higher than F. Navasari cotton. In Bassein on the coast north of Bombay, the following general conclusions were drawn :—The Bourbon gives a crop during the first year ; it thrives best in black soil ; that cattle manured plots produce a larger outturn of seed cotton than pruned and unmanured plants. So far the Bourbon is the only form which has been subjected to field tests by farmers, especially near Deesa, and their experience proves that the plant fails in outturn. Experiments are, however, still in progress to find out whether or no a more satisfactory result can be obtained by more careful methods of cultivation and pruning. All that can be said at present regarding the prospects of tree cotton cultivation is that every endeavour to grow various kinds on a large scale has failed disastrously. At the Nadiad Farm in Gujarat it was found that the vegetable *Bhendi* (*Hibiscus esculentus*) grown in the Bourbon plots, covered the expenses of irrigation by the sale proceeds of its crop. At the Guneshkhind Botanical Garden near Poona, acclimatised soft Peruvian was considered to retain its native characteristics by competent judges who valued it at Rs 400 per candy or Rs. 100 more than F. Navasari.

Indigenous Cottons.—The possibility of improving these by selection has been kept plainly in view for some years, and some valuable experience has already been gained. In 1904, a specially good plant of Broach was observed and seed has been sown continuously since from this and its descendants. Last year an area of 7 acres was sown with this cotton. The yield varied

between 500 and 600 lbs. per acre with a ginning percentage of 32·5, which is an advantage of ·85 per cent. as compared with the result from an unselected sample. At Dharwar, selection has been going on during the same period from the local cotton. As the object aimed at was quality, this has been secured at the expense of the ginning percentage which has fallen from 25 to 23·36 per cent. In Bombay one lesson learned is that within a variety the quality varies more or less inversely with quantity. The selected cotton was valued at Rs. 265 when ordinary *Kumpta* was valued at Rs. 248 ; at the same time cotton grown on Dharwar farm from Broach seed was valued at Rs. 270 to Rs. 275, with a ginning percentage of 30·62 to 32·81, so that the policy of the Department of encouraging the extension of cotton grown from imported Broach seed is economically sound. The fact that selected Broach grown at Dharwar in 5 years dropped in percentage from 32·81 to 29·51 proves the necessity of frequent imports of fresh Broach seed to check the inevitable deterioration which accompanies attempts at each acclimatization. At Dohad, in the Panch Mahals, it was definitely ascertained that no cotton, which did not yield before the end of December, could be successfully cultivated on account of the damage liable to be done by frost. Khandesh cotton yielded at the rate of 539 and 496 lbs. of seed cotton per acre, as the bulk of the produce was harvested before the frost came. Cambodia cotton, introduced from Cochin-China, also did fairly well. It yielded at the rate of 468 lbs. of seed cotton per acre before the frost occurred. It is unlikely that any other variety of cotton will succeed unless it is sown early in the year under irrigation. At Dhulia in Khandesh a prolonged study of the local forms has clearly established the fact that they consist of a mixture of at least six types and that some of these are better than others. The distribution of seed of the best type has already been commenced.

In the Southern Maratha Country, where the staple of the Dharwar American cotton varies from $\frac{3}{8}$ to $\frac{7}{8}$ of an inch, work in selection has been initiated

of the staple, but also to fix a green seeded type which bears longer cotton with a ginning percentage of 1 to 2 per cent. higher than that of the white seeded variety.

Hybrid Cottons.—In spite of long continued and laborious study little or no progress has been effected in establishing stability in these and as a final resource the method of the unit system has been introduced. One general conclusion arrived at on the Surat Farm is that at least three of the hybrids are now equal to the best Navsari. Some crosses made between different kinds of Uplands at Gadag are yielding hopeful results. At Nadiad in northern Gujarat, some excellent crosses have been evolved between Texas and Bourbon and also between Egyptian and Sea Island and Bourbon. The purpose of the crosses was to remove the objection to Bourbon that its bolls opened badly causing weakness in the fibre. All the crosses made proved superior in this respect and the subjoined statement shows that the results are so far encouraging, see page 51.

At Dhulia hybridizing experiments have been conducted with the view of combining quality and outturn in the local cottons.

In the Central Provinces an experimental farm devoted mainly to the investigation of problems relating to cotton and *juar* has been started at Akola in Berar. There it has already been demonstrated that tillage causes the land to absorb and retain all the rain that falls on it. The separation and selection of the different types of *neglectum* cotton which exist in Berar have been carefully conducted and the variety known as *malvensis* has proved superior so far both as regards quantity and quality.

The most important fact, however, that has come to light during the course of these experiments is the suitability of a higher class cotton for the soil of Berar in Bani tracts, namely, *Buri*, an acclimatized form of Upland Georgian in Chutia Nagpur. This has been valued at 50 per cent. more than any of the local cottons. The chief drawback to its cultivation is that it may suffer more from drought than the local *Jari*, but still it may pay the cultivator to take the risk. Another step in advance which

Register No.	Name of Hybrid.	Area grown in 1908-1909 in gunthas.	Ginning percentage.	Yield per acre in lbs. of seed cotton.	Valuations.			
					The Bombay Cotton Trade Association.		Through the Imperial Cotton Specialist.	
					Value in rupees per candy of 784 lbs.	Remarks.	Value in rupees per candy of 784 lbs.	Remarks.
1371	Texas Bourbon (35T) ...	10	24·2	753	260	"Rather dull in colour, nice staple."	300	"Navsari style of cotton."
1370	Do. do. (23T) ...	10	26·2	688	260	"Dull and stained but nice staple."	260	Ditto ditto.
1368	Do. do. (15T) ...	10	...	705	...	Not valued	...	Not valued.
1367	Do. do. (13T) ...	10	...	1,114	...	Ditto	...	Ditto.
1380	Abassi do. (21T) ...	5	26·5	216	265	Dull colour but very nice staple	350	"Egyptian style."

has been taken by the Department is the establishment of eight seed farms in tracts where they are immediately under the eyes of the cultivators. Here varieties which have been approved of in the experimental farms are produced in large areas and the seeds distributed to cultivators. At the end of year 1908-09, 8,245 lbs. of Buri seed had been distributed in Berar, 1,714 lbs. in the Central Provinces and 1,000 lbs. in the Feudatory States. The lowest outturn on the farms was 300 lbs. of seed cotton per acre and the highest 1,080 lbs. It was not affected by wilt and the percentage of cotton to seed was as high as that of *jari*. Its tolerance of a higher rainfall gives promise of success even at Rajnandgaon and Raipur. The cultivation of Buri by farmers who buy and sow the seeds is fortunately not left altogether to their discretion because the trained agricultural assistants who are in charge of the seed farms in Berar also supervise the operations proceeding in the districts.

In his manurial experiments on cotton, Mr. Clouston still finds an advantage in the use of a nitrogenous fertilizer in a manurial dressing. As regards rotation, it seems that cotton and *tur* in the first year and *juar* in the second and cotton and *juar* in alternate years are easily first, thus confirming the value of the local practice.

In the Akola Farm, owing to the abnormal character of the two seasons the farm has been in existence, some experiments so far have yielded negative results and others of a more obvious nature have confirmed facts, such as that as long as the number of cotton plants are not crowded, the larger the number the greater the yield. On poor soil, the cultivator does not thin out the plants at all but allows all to come to maturity. In a favourable year and in good soil, however, the growth of the plots is greatly increased and fewer can be grown with advantage to the area. Trials are in progress to ascertain the most profitable spacing distance to adopt on heavily manured soil.

Another series of trials laid down to ascertain the relative values of the outturns of different cottons have so far been discounted by adverse circumstances of which water logging was the

chief. Under these unfavourable conditions, however, *Buri* surpassed all but Berar *jari*.

Samples of all these cottons were reported on by Khan Bahadur Bezonji, the Manager of the Empress Mills at Nagpur, as follows :—"Verum and Malvensis are good types of *jari*. The staple is rather fine and long for *jari*; they would be worth about Rs. 5 more for *boja* of 345 lbs. Rosea and Cutchica are the useful types of *jari*, with fibre short and coarse. The Buri cotton is long in staple and better than Bani. The Upland Georgian may be considered equal to Bani."

The following is the statement of outturns as given by Mr. Clouston :—

No. of plot.	Name of cotton variety.	Outturn of seed cotton per acre in 1907-08.	Outturn of seed cotton per acre in 1908-09.	Percentage of lint.	Value of Outturn.		
		lbs.	lbs.	lbs.	Rs.	As.	P.
1	Malvensis	240	264	32·00	25	14	10
2	Verum	182	274	32·65	26	14	6
3	Roseum	258	342	38·04	33	9	5
4	Roseum Cutchica	194	317	38·05	31	2	1
5	Berar Jari	255	429	38·00	42	2	1
6	Upland Georgian	84	370	29·00	39	13	1
7	Buri	77	426	33·90	53	4	1
8	Bani	151	246	26·78	28	8	10

It has always been a moot point whether topping the young plants is really beneficial or not. The Akola trials so far demonstrate that the chief difference between topped and untopped plants is that the latter throw out new branches and mature three weeks later than those allowed to grow naturally.

The series of experiments designed with the idea of gauging the profits to be derived from the use of fertilizers as manures for cotton grown on black cotton soil has already shown a few indications of result, such as that highly soluble artificial fertilizers are not profitable when applied without a more bulky organic manure, that when applied along with so bulky a manure as cattle dung, however, both nitrate of soda and nitrate of potash are likely to prove profitable manures; that the nitrogen

of nitrate of soda appears better than the same quantity of the nitrate of potash; that 10 lbs. of nitrogen in either form along with 64 maunds of cattle dung is more profitable as a manure for cotton than 20 lbs. of either fertilizer with 32 maunds of cattle dung. Another series of trials which may probably bring out a profitable idea for the farmer is to determine the comparative values of cattle dung and urine as manures for cotton, the urine being conserved by the dry earth system. Cotton and *juar* are to be grown in rotation and the manure applied every year. Mr. Clouston is certain that by adopting the dry earth system of conserving the urine of his cattle a farmer can double his supply of manure.

In the Madras Presidency, where well directed efforts have been persevered with for some years past, the Director has furnished a clear account of the work already accomplished and the following is the brief abstract of this.

In the matter of cultivation, in the Ceded districts where the use of the drill is universal, the only improvement calling for attention is the introduction of heavy iron ploughs already extensively used in parts of Bellary. Already, in spite of the extreme backwardness and conservatism of the Kurnool *ryots*, seven orders have been received for these ploughs, and their use is certain to spread as the value of the implement becomes established. In Tinnevelly, about 1,000 acres of privately owned land were sown with the drill, an entirely new introduction to this part of the Presidency. An inspection of the fields showed their superiority over broadcasted crops, as, the year being dry, the seeds were sown at an uniform depth and the soil moisture was conserved by frequent interculture. It is also asserted that sowing can be done more quickly by the drill. The *ryots* who have adopted the new method are fully satisfied as to its merits, and were more trained instructors available, the spread of the new system would probably be very rapid. The experiments in irrigating cotton at Hagari show that the yield of country cotton can be increased thereby in a dry season, but unfortunately not enough to cover the cost of laying out the land for irrigation and

payment of water rate. In ordinary seasons there would be no advantage whatever. The *ryots* who enjoy the facilities offered by the Kurnool canal are said never to use the water for cotton. All attempts to grow superior varieties of cotton with the help of irrigation have failed.

In the northern parts of the Presidency, owing to the mixture of varieties, seed distribution on a large scale has not been possible. Certain information, however, has been received to the effect that the two varieties of white seeded cotton, Gadag and White Northerns, were adjudged to be superior in every way to the *Yerra-patti* (brown lint) and *Nallapatti* (black seeded white lint) which at present occur in the mixture known to the trade as Northerns.

Forty-five acres of land have already been taken up for growing seed of pure white seeded Northerns and the seed will be distributed. Ultimately it is intended to expand the line of work with a view to raising the general type of cotton produced in the district and maintaining it on a higher level.

In Tinnevelly, where the cultivators are more intelligent and also where only two types of indigenous cotton are grown—*Uppam* and *Karunganni*—the problem is simple and the more so because several experts have declared that *Karunganni* is superior to *Uppam*. It appears to be at least as prolific as *Uppam*. Seed distribution has therefore been taken up on a large scale and last year sufficient for about 8,000 acres was sown. During this year seed was grown on 263 acres of *ryot's* land for distribution by the Department. It is to be hoped that the proportion of *Karunganni* will increase in Tinnevelly cotton and hence give it an enhanced value.

In their attempts to effect the improvement of cotton the officers of this Department have learned by experience that better results are likely to accrue from selection of their local varieties than from the introduction of varieties from foreign countries or from other provinces in India or even from other parts of their own Presidency. Trials in the dry tract of Bellary distinctly prove that in a bad year no variety yet dis-

covered will fare better than the local "Jowari." One great objection to it is its low percentage of cotton to seed, this being only 25, but selections made and partially tested already show over 30 per cent. A certain amount of attention is also being paid to the call from Indian mills for a longer staple cotton which will make the country independent of the American supply, and the study of Bourbon cotton, the only long stapled variety in the Presidency, is being taken up. At present it loses its value because it comes into the market mixed with a short stapled cotton.

A variety of *G. hirsutum*, known as Cambodia, is now being extensively cultivated in the Tinnevelly district on land commanded by wells. It is a risky crop to grow on dry lands, but it is expected that its introduction will prove a useful one. When the officers of the Department realise the possibilities inherent in this variety, they will make strenuous efforts to test it thoroughly, as it is perhaps the most promising cotton of Upland type ever introduced into India.

In the Punjab, although its Agricultural Department is one of very recent organisation, a few important details on the subject of the cottons likely to be of use in the province have already been established. Many of the American cottons have given very good results. Two varieties have already been selected to be tested on a field scale. The Buri variety from Bengal also promises well. The African varieties have been found to be too late in ripening to suit the requirements of the Punjab. Egyptian cottons fail when grown under local conditions and their chance of success seems very remote. Five varieties of indigenous cotton, fairly true to type, have been sown on large plots. Direct evidence has been found that cross-fertilization does take place in cottons. The tree cottons, as might be expected, produced no crop of any value whatever. A collection of Punjab cottons was made and the plants grown for botanical purposes. It was found that practically each of these was such a mixture of types that it was difficult to say which was the predominant one.

As is the usual experience all over India, the excessive rains in the cotton flowering season caused a larger number of the early flowers to fall off and consequently diminished the outturn considerably.

In the Administration Report of the Director of Agriculture for the United Provinces of Agra and Oudh, a meagre account only is given of the progress of cotton improvement in his province. It is to the effect that 360 maunds of American acclimatised cotton were sold mostly in the Aligarh district. The season of 1908 was unfavourable to all kinds of cotton and the yield was very poor. The Department purchased such cotton as was brought to it and arranged for ginning and disposal to spinners. The future of the crop still seems doubtful. If sown early enough, it grows well and yields heavily, but the problem of getting it to market unmixed with country cotton and in quantities large enough to attract buyers is still unsolved.

These provinces of course yield the class of cotton known in the trade as "Bengals." There is little hope of ever improving these to a sufficiently high standard and it is a matter of regret that the officers of the Department do not realise the necessity of supplanting them by some form of Upland cotton for which the climate seems quite suitable.

In Burma, where the Department has not enjoyed sufficient time as yet to accomplish any thing definite, the Director states that the general unsuitability of the Lower Burma soil and climate for cotton has again been indicated. Before attempting to introduce exotics in Upper Burma efforts are being directed towards a thorough examination of the varieties now grown with a view to ascertaining the possibilities of improvement by utilising the best of them. A variety found in the Northern Shan States has obtained a very favourable report from a Bombay firm and is now being tried at the Mandalay Agricultural Station.

In Bengal, which lies practically altogether outside the great cotton tracts of India, an experiment with Buri, a variety of Upland Georgian acclimatised in Chutia Nagpur, has rather disappointed the officers of the Department, but further trials

with this, the *Dishila* and the Bourbon will, I am certain, show them that cotton of good quality can be produced at a profit in Bengal.

In Eastern Bengal and Assam we have a striking instance of an abnormal variety of cotton growing under what we also consider abnormal conditions of climate. This cotton is grown only by the aboriginal hill tribes under a primitive system of agriculture, and it is so harsh in its nature that it is said to be used only in Europe as a substitute or adulterant of wool. Attempts to grow other varieties of cotton fail uniformly on account of the heavy rainfall. The variety grown in the Garo Hills is taken as the best of the hill cottons and trials with its seeds will probably be made throughout the hill tracts of the province in general.

FIELD EXPERIMENTS.

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A NUMBER of experimental farms have been established at one time or another in India, particularly in the more accessible parts of the country, where agriculture is already developed to a very high degree of efficiency having regard to the economic conditions under which it is practised; it is therefore reasonable to suppose that the more obvious improvements will shortly have been effected and the more obviously crude practices have died out, and that in future the margin of profit to be made by any departure from local practice will tend continuously to decrease. In proportion to this decrease will be the increase of the importance of pursuing scientific method on experimental farms, in order to estimate, as rapidly, certainly, and accurately as possible, the relative advantages of different practices.

For the purpose of such estimates, field-experiments may be broadly divided into two classes,—those that necessitate the comparison of the yields of crops, and those that do not. The latter involve little but care and actuarial calculations, and are not complicated by incalculable factors that give any special difficulty; whereas in the former, the whole range of physical and chemical differences of soil comes into play, and if the variation in fertility due to these differences is at all considerable, the usual methods of tabulating and comparing the results of comparative experiments are of very little use. In fact, judging from attempts that have been made, at points so far apart as Lyallpur in the Punjab and at Sabour in Bengal, to test the fertility of fields to be used for experiments, there is reason to suppose that this variation in fertility, within a short distance, is so great in

some of the alluvial soils of India, as quite to obscure the results of comparative experiments, unless special precautions are taken to minimise and discount such variation. An account of these attempts, and of a system devised to discount the results, may therefore be of interest to workers in this field.

The plots in both cases were laid out so as to be of the minimum breadth compatible with ease of cultivation and of the maximum convenient size, on the obvious principle (followed in laying out the classical experiments on wheat at Rothamsted), that, while small local variations in the fertility of the soil will be neutralised by one another to an extent proportional to the size of the plots, any large general variation is likely to be gradual and continuous, and that therefore the probable normal difference of fertility between two small equal adjoining plots will vary more or less directly as the distance between their centres—that is, as their breadth.

At Lyallpur the plots were 220 yards long by 11 yards broad; the fertility of the land was tested in 1907, previous to the laying out of the plots, by dividing a standing crop of a uniform variety of wheat into small squares and weighing the produce of each. The variation in fertility from side to side of the field in a direction across the future plots was then plotted in a curve, as explained below and as shown in the diagram (fig. 1). This result was roughly tested and confirmed in 1908, and shows the great influence of the soil factor, which caused a variation in yield of about 20 per cent., in plots in the same field, and an average variation of about 3 per cent., in 11 yards when adjoining plots are compared. The plots at Sabour have been laid out similarly, but are of double the size, roughly 340 yards long by 15 yards wide; they have been tested for one year only by the growth of rape, with the result shown in fig. 2. The testing will be continued for a year or two, as some of the land is known to have been highly manured in the past, but it is clear that here again the variation in the soil would, in the absence of such definite information as will be obtained by successive testing, completely obscure anything but the most marked results of experiments.

How such variation is to be discounted is therefore likely to be one of the most pressing problems before those who try comparative field experiments in India, for in few cases is the land available likely to be approximately uniform, and time can not be afforded to reduce it to uniformity, even if that were possible.

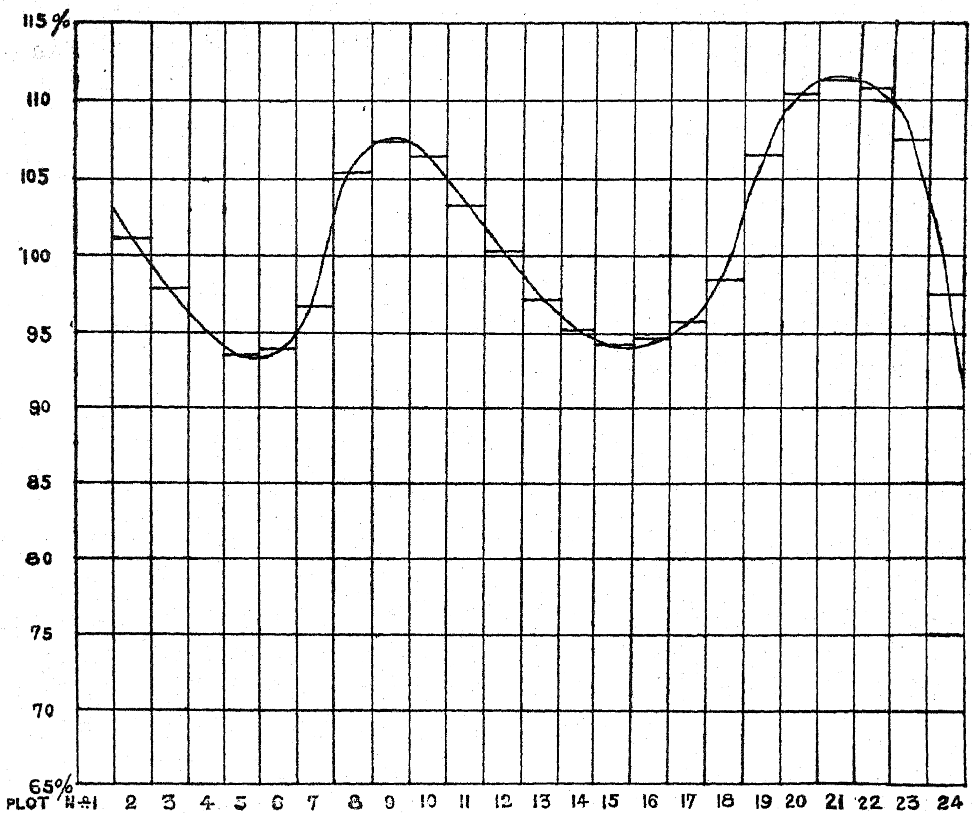

FIG. 1.—CURVE SHEWING VARIATION IN FERTILITY OF A FIELD AT LYALLPUR.

Looking at the diagrams given above, some of the principles on which the solution must depend become clear, *viz.*:—

1. Plots, the outturns of which are to be compared for scientific purposes, must be as long and as narrow as possible.
2. The differences of fertility of the plots should be tested before starting the experiments and taken into account in subsequent comparisons.

And in view of common experience of the manner in which the fertility of the land varies from year to year, according to its previous and present treatment, we may safely add—

3. The land should be tested again, every year, unless and until such tests may show that, owing to uniformity of treatment, progressive variation has ceased.

The last of these may perhaps seem difficult to put into practice, because it means that plots must be selected, at representative points on the curve plotted in the first year, and again normally treated every year, to the exclusion of experiments on those plots; but, until such testing has been satisfactorily finished, only plots that are alongside of one another can in any case be used for comparison, with any likelihood of reliable results, and there seems no reason why the experimental area should not be so laid out that every other plot should be always normally treated, being used as a "control" both for the experimental plot on each side of it and for the variation in fertility of the whole field under normal cropping. If this system increases the number of plots necessary to carry out a given number of experiments, it ensures, on the other hand, more immediate and reliable results than could be obtained by any reasonable amount of the duplication of experiments which is generally considered necessary to lessen the effect of the indeterminable factors which such a system eliminates.

An essential part of such a system is the "normal" treatment of the "control" plots. It is on all counts desirable that the progressive variation of fertility of the field as a whole should be brought to an end, and normal conditions established, as soon as possible. This implies that the whole field should be so cropped as to be reduced, or worked up, to fair fertility, and kept there. The work done at Rothamsted has made unnecessary the repetition of academic experiments on a field scale, and enables us to work within the ordinary canons of good husbandry; and there seems no reason why the area devoted to comparative experiments on a farm, should not be normally cropped with a standard rotation, compiled with regard to local practice, so as

to be both conservative and profitable. Each year of the rotation would be represented on the land by one block of plots, uniformly cropped except for the experimental treatment given to every alternate plot. Every experiment which affected the fertility of the soil could be tried on corresponding plots in each block every year ; other experiments as far as possible on different plots every year ; and any practice found unquestionably profitable could be substituted for the "normal" treatment on the "control" plots.

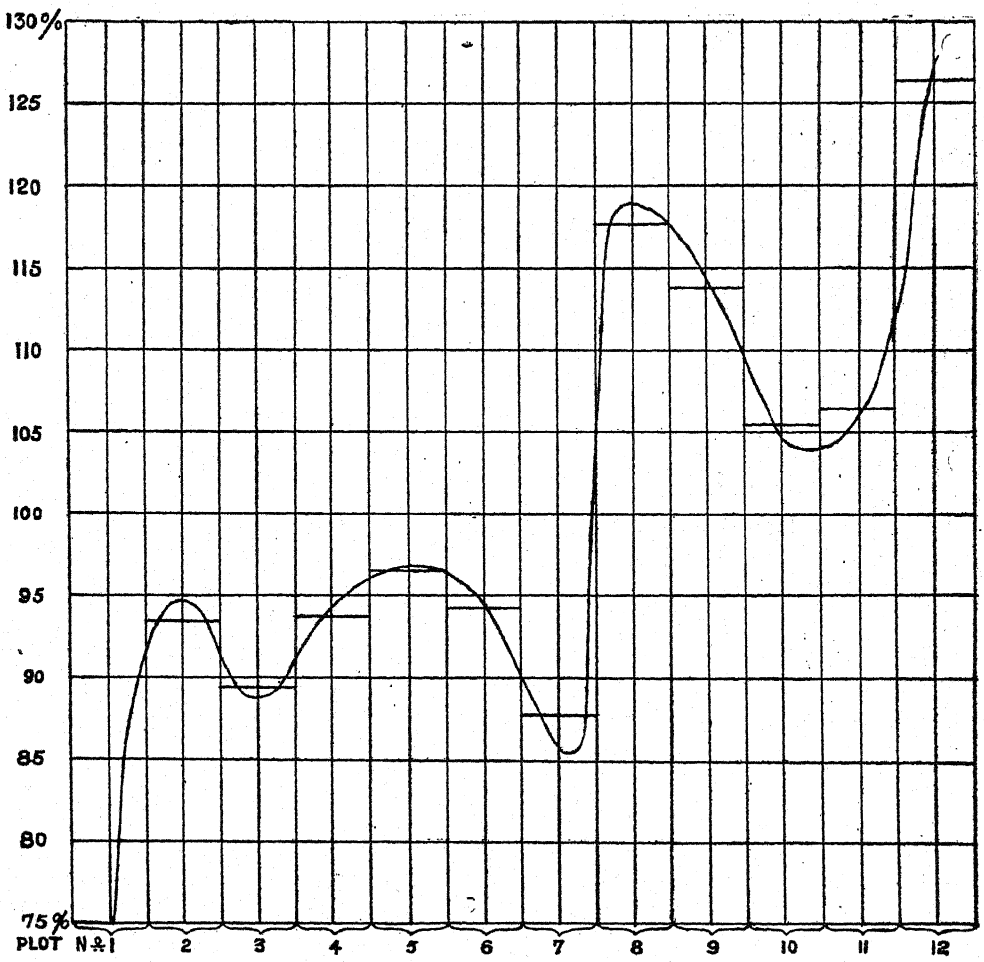

FIG. 2.—CURVE SHEWING VARIATION IN FERTILITY OF A FIELD AT SABOUR.

Such a course has the immense advantage of providing a practical 'control' for every experiment, instead of its being

made, as is too often the case, on the basis of some impracticable and unprofitable system such as the growth of several cereal crops in succession on the same land.*

As a concrete example, the experiments carried out at Lyallpur will serve to illustrate a method of estimating the results of experiments planned on such a system as is here suggested; it is not an example to be followed because the experiments were complicated far more than was desirable, in order to test some manures, information regarding which was urgently required; but it is perhaps all the more useful as an illustration.

The fertility of the field was tested in 1907 and gave the curve of fertility, shown in fig. 1, and reproduced as the black line in fig. 3. The following method was used to plot this curve:—Up and down lines are taken to represent divisions between equal narrow plots in the field; a cross line in the middle of the paper is taken as a base line, representing the average yield per acre of all the plots, and is numbered 100. Percentages above or below this are marked according to any convenient scale on the marginal lines.

The yield of each plot, calculated per cent. of the average, is now marked by a line parallel to the base line across the plot, at that percentage.† Now if the width of the plots could be indefinitely decreased and their number similarly increased, and if no abrupt difference of soil or treatment occur in crossing from any one plot to the next, these lines would ultimately merge into a continuous curve, showing the gradual variation of fertility of the field from side to side in a direction at right angles to the plot boundaries.

* The Rothamsted experiments have shown us both what to do and what not to do in this respect; they are, for the most part, incapable of direct application, in practice, because the "control" provided is, purposely, a system which exhausts the land: and it is hardly too much to say that the value of nitrates has probably been considerably exaggerated, in England, owing to the omission on the part of the public to take this fact into account.

† The actual plots used for this purpose were not those shown here, but the curve shown having been plotted for this field from the original materials, not now available, the estimated yields of the new plots laid down in 1907 have been marked for purposes of illustration. In fig. 2, the actual percentage yields of the plots at Sabour are marked in blue and that figure will perhaps serve better as an illustration of how the curve is actually drawn.

This curve, as will be seen subsequently, is the key to the interpretation of the results obtained on the plots, and it is therefore important to plot it carefully. But as, in practice, the width of the plots cannot be decreased beyond a certain limit, it is necessary to obtain the curve by estimation.

The yield of each plot tested is therefore marked, as stated, and the curve is sketched in, care being taken that it makes equal areas on opposite sides, with the line denoting the yield of each plot and the sides of the plot.

This curve shows the variation in fertility of the field for wheat in 1907. The curve for another crop or another season might be entirely different, and there is no doubt that the preparation of a series of these curves, for the same field under different crops, and for several seasons, would throw a most interesting light on soil and crop problems, particularly if compared with charts of the meteorological conditions, and of the physical composition of the soil.

But meanwhile, for the immediate purpose in view, it was necessary to assume that the curve was to some extent independent of seasons, and to trust to the test plots for any evidence to the contrary. Normal cropping, under a rotation intended to be permanent, was therefore begun in 1907-08. It was desired to test five samples of wheat while at the same time re-testing the fertility of the land and trying the effects of nitrate of lime and of calcium cyanamide on wheat. Under the somewhat elaborate 12 years' rotation selected, plots 1, 2, 3, 4, 5, 6, 13, 14, 15, 16, 19 and 20 fell under wheat.

It was decided to use these plots in the following manner:—

(1) All the odd numbers to be control plots, sown with a standard sample of wheat, for comparison with the outturn of the five samples of wheat, sown in the alternate plots.

(2) Plots 1, 5, 13, and 19 for re-testing the land.

(3) Plots 3 and 15 for the manurial tests.

(4) The even numbers for the five samples to be tested, one sample being sown in duplicate plots.

Plots 4 and 16 were given the same manurial applications as plots 3 and 15 respectively, so as to make a direct comparison between 3 and 4, and between 15 and 16 possible. When the results came to be interpreted, it became evident that several mistakes had been made in the planning of the experiments. Firstly, the rotation was too complicated, separating, as it did, the plots under wheat, and thus doing away with the advantage of having a control plot on each side of every experimental plot. Secondly, the manurial experiments should have been substituted for two of the sample tests instead of being superimposed on them. Thirdly, more plots should have been reserved for re-testing the fertility; and in particular there should have been one at each extreme point of variation, whereas plot 15 received calcium cyanamide, and therefore gave no check on any progressive variation in relative fertility at one of the least fertile points. As it happened, the results of plot 1 had to be rejected owing to the depredation of sparrows along the margin, and thus the actual yields of only three plots were left to check such variation. Fortunately the sample sown in plot 2 was the same as that sown in plot 20, these being the duplicate plots referred to above and so it was possible to estimate the probable yield that the standard sample could have given in plot 2 from the actual yields of plots 2,19, and 20.

These mistakes and accidents make any interpretation of the results more difficult and ambiguous, but not impossible. To attempt an interpretation, a diagram is prepared as shewn in fig. 3. The 1907 curve is first transcribed. The yields of the test plots in 1908, *i.e.*, of plots 5, 13 and 19, calculated as per cent. of their average yield, are now marked as shewn in blue. Plot No. 1 being out of court, the yield of the standard sample is estimated for plot 2 as suggested above, and marked with a dotted line in percentage of the same average. The curve of probable fertility for 1908 is now sketched in, the limiting conditions being :—

1. That it should be as far as possible conformable to the curve of 1907.

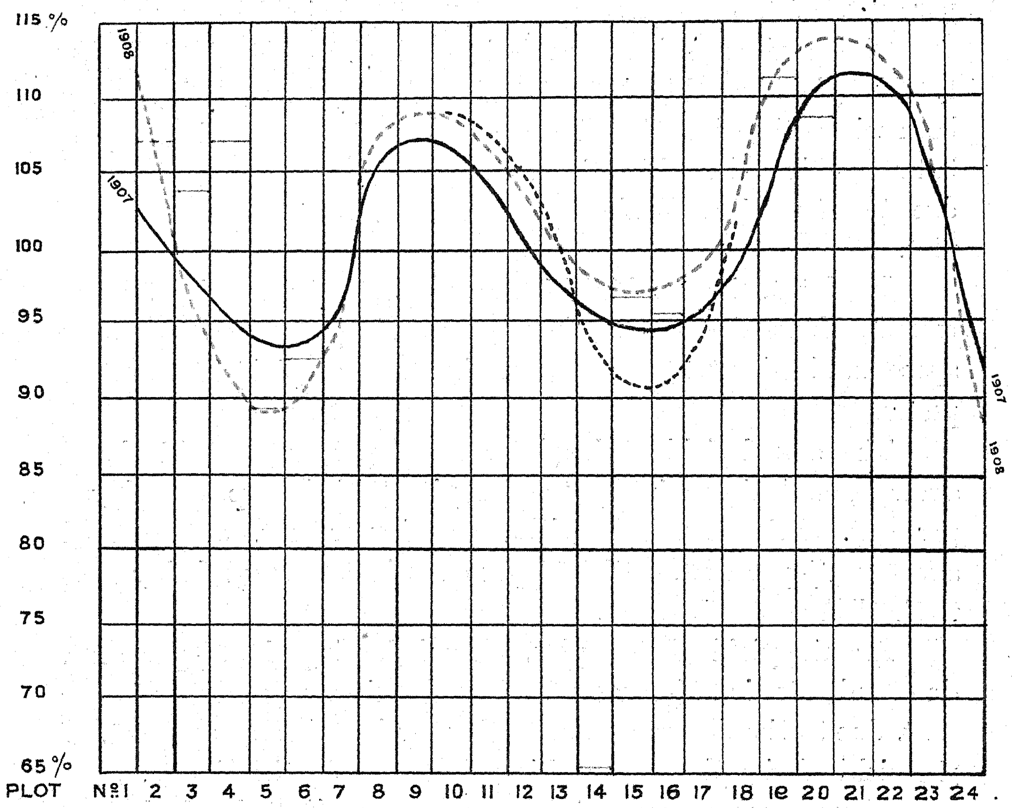

FIG. 3.—DIAGRAM TO ASSIST IN DISCOUNTING THE VARIATION OF FERTILITY IN INTERPRETING THE RESULTS OF EXPERIMENTS.

2. That it should cross the test plots so as to make on opposite sides, equal areas with the sides of each plot and the blue line representing its yield for 1908. This curve, shown in red in fig. 3, is dotted where it crosses plots other than the test plots.

The actual yields in 1908 of all the other plots, calculated er cent. of the same average, are also shown in blue.

The results now become relatively clear. To begin with plot , the yield would, but for the nitrate, presumably have een where the dotted red curve crosses the plot, and the space etween this and the blue line represents the percentage increase ie to the nitrate—about 8 per cent. of the yield of the ot.

In plot 4, the combined increase due to the sample of grain sted and to the manure is represented by the corresponding ace and is about 16 per cent. of the average yield of the test ots.

The actual yield of the plot was 107 per cent. of this basal erage, and the gain due to the nitrate being presumably 8 r cent. of the actual plot yield, or $8\frac{1}{2}$ per cent. of the basal erage, $7\frac{1}{2}$ per cent. of the 16 per cent. is left as probably due the difference of sample.

As the yield of the plot, after deducting the $8\frac{1}{2}$ per cent. e to nitrate, is $98\frac{1}{2}$ per cent. of the basal average, the $7\frac{1}{2}$ per nt. due to the difference of sample may be taken as per cent. of e yield of the plot after making allowance for the nitrate.

These somewhat unsatisfactory and complicated calculations necessitated by the superimposing of two experiments on the ne set of plots.

Coming now to plot 6—the result shows a difference of out 2 per cent. in favour of the sample tested in that plot.

In plot 14 a difference of about 32 per cent. in favour of the ndard sample, is accounted for chiefly by the fact that the nple tested was a broad-leaved durum wheat which is known require much more water than ordinary wheats, but which s given the same amount as the rest.

On plot 15 the effect of the calcium cyanamide, which was applied late, appears to have been nil; but, taking into consideration the depression of the 1908 curve at plot 5, which plot crosses a patch of "kalar" land at its centre, and in view of the fact that plot 15 crosses a similar patch near its centre, it is doubtful whether part of the lowness of yield of plot 14 was not due to an increase of "kalar" salts, such as has apparently taken place in plot 5, and whether plots 15 and 16 were not saved by the manure from participating in such a decrease.

If plot 15 had been a test plot in 1908, the curve for that year might have shown a depression at that point, as suggested in the dotted green curve, similar to the depression at plot 5; the mistakes alluded to above are responsible for this ambiguity.

As regards the remaining plots, plot 16 shows a difference of about 2 per cent. and plot 20 of about 4 per cent. in favour of the standard sample of wheat.

On the whole, these results are remarkably in accordance with what was to be expected. Considering the demonstrated variation of 20 per cent. in the fertility of the plots and comparing these results with those of the experiments of many previous years as given in annual reports of the Lyallpur Experimental Station—experiments carried out by the same subordinate staff but, interpreted without the aid of any test of fertility—these results show a conservatism which is in itself an argument in favour of giving some such system a trial wherever the results of experiments involving the comparison of crop yields may, hitherto, have appeared unsatisfactory.

ꝚEPORT ON JUTE AND FLAX EXPERIMENTS DURING THE PAST YEAR.

By R. S. FINLOW, B.SC.,

Fibre Expert to the Government of Eastern Bengal and Assam.

I.—JUTE.

Cultivation of Pure Cultures.—Up to the commencement of ıe present year, the main portion of the work on jute was ɜvoted to a study of the types of plant which are cultivated r the production of fibre. This stage of the work may now be id to have been brought to a conclusion and a short summary ll not be out of place. It is, of course, well known that there e two botanically distinct varieties of jute, *viz.*, *C. capsularis* d *C. olitorius;* but, included under each of these main heads, ɜ a large number of races, which it was necessary to classify d compare. Extensive tours, made throughout the jute-ɔwing districts of Bengal and Eastern Bengal by Mr. I. H. ırkill, the Reporter on Economic Products to the Government India and by the writer, showed that several types of *C. ɒsularis* each of which is generally known by a distinctive ɜe are cultivated in each district and the result of this pre-ıinary enquiry was that seed of over one hundred races or ɔes was collected and sown in plots at Pusa. It was found examination of these plots, that the seed samples of many ɨes were very mixed and that many of the plots contained not ɜ but several types of plant. The races had, therefore, first be purified by selection before any real comparisons could be de between them. This portion of the work was rendered ier than it might have been because it was found that, in ıost every case, the seed of each type of plant produces plants

similar to the parent. This is due, as is shown below, to the fact that jute in the jute districts is normally self-fertilised. Nevertheless, the work required great care; because it was found that the races differ not only in colour, but also in time of maturing; so that a plot which appears quite uniform in the early stages of growth might ultimately prove to be composed of types of plant which differ considerably. After this process of selection had been carried through, it was found that many of the races, although passing under different names in different districts, were to all intents and purposes identical and the number of distinct types was ultimately reduced in this way to about 15. This represents the end of the first stage of the work, as a result of which we were placed in possession of fairly pure specimens of practically all the races of jute in Bengal.

The races of *Corchorus capsularis* present three distinct types of colour of stem, *viz.*:—

(a) Deep red.
(b) Russet red.
(c) Green—I (with green fruits).
II (with reddish fruits).

Under each colour-head, there are early and late maturing races. It has been noted that the late maturing races are generally taller than the early maturing ones; so that the former are likely to produce heavier yields of fibre than the latter. All these characteristics are hereditary and we are able therefore, in distributing seed, to do so with due regard to the conditions under which the crop is to be grown.

Side by side with this field work an investigation of the chemical and microscopical characters of fibre samples obtained from each of the respective races of jute is being carried out, the object being to determine whether or not any one or more of the races could be distinguished from the others as producing fibre of a superior quality. The natural outcome of this portion of the work should be the elaboration of a method of plant to plant selection for the production of a superior race of jute. Such

esults in the case of crops like wheat, sugarbeet, etc. The ifficulties which confront us in this work, however, are considerble, partly because of the fact that the fibre which we wish to xamine is a part of the structure of the plant. It is obvious, for istance, that if the plant be destroyed, as is usual, in order to obtain s fibre, no seed could be obtained to sow, in case the examination the fibre indicated superiority. Such a difficulty does not exist the selection of cereals. Another difficulty is that, as far as e can ascertain, excepting cotton, the selection methods for hich would probably not apply in this case, no other work has therto been carried out, having for its object the improvement a fibre crop by direct selection. The progress has, therefore, cessarily been slow. We have, however, noted small but stinct differences, both chemical and microscopical and seed om each of the plants examined, the respective fibres of which ve shown any indication of superiority has been sown separately each case. An examination of the progeny is now about to e place. Whether such differences as these are intrinsic in plant or whether they are mere accidents, of environment instance, is a matter which only further observation can ide. It remains to be said that the selection work is laborious, pending largely as it does on microscopical measurements. indication of its nature may be gathered from the fact t, in the selection of about 30 plants, it was necessary t year to make something like one hundred thousand actual asurements, under the microscope, of the tiny ultimate ments, by the cohesion of which the long strand of fibre is duced.

Cross-fertilization Experiments.—The first of these interest- experiments, commenced in 1908, have now advanced as far he second generation of the hybrids. They were designed to w light on the nature of the origin of the different colour s of plant, already enumerated, which have come under our ce. It is not necessary to go into details here, but it may aid the result of crossing a pure green race of jute with a red coloured one has been ...

(1) That the colour of the stem in jute is a Mendelian characteristic.

(2) That jute is normally self-fertilised; so that (*a*) an improved race if introduced would not be in serious danger of being speedily swamped by free crossing with inferior races. (*b*) In comparing one race with another, it is not necessary to take any special precautions to prevent contamination of the one race with the other.

It may be possible in the future to extend this work in various directions.

Jute in the Chittagong District.—These experiments originally commenced to investigate the possibility of the successful cultivation of jute in Chittagong have progressed so far as to show that excellent jute can be grown on high lands. More recent experiments have been devoted to utilising the low rice lands for jute in the period between the reaping of the one paddy crop and the planting of another. In 1908 sowing in April was unsuccessful, owing to the water-logging of the land. This year the land was ploughed in early January, as soon as possible after the paddy crop had been reaped and sowing also took place in January. The crop germinated evenly and looked promising in the middle of April. A long drought followed, however, and the seed being that of an early race, the plants matured prematurely; thus spoiling the crop.

It is proposed to repeat the experiments next season with a later race; the experiments are not very costly and they are yielding useful information regarding the habit of the jute plant; moreover, a successful result would be applicable far outside the Chittagong district.

Bombay.—In 1909 a crop of jute at Belgaum yielded fibre at the rate of 1,570 lbs. (19·5 maunds) per acre valued at Rs. 6 per maund. The expense of production was, however, so high as in the opinion of the Deputy Director of Agriculture to preclude the possibility of growing this crop at a profit in Bombay.

Central Provinces.—Jute was

‹heri (Nagpur). This year's crops are also satisfactory and :he Deputy Director of Agriculture considers that there is ιow no difficulty in producing excellent crops of jute at the above xperimental farms. It is interesting to note that *Corchorus litorius* seems to thrive better, on the whole, in the Central ᵓrovinces, than *Corchorus capsularis.*

Distribution of Seed.—During the present season, 70 maunds f jute seed have been sold and above 20 acres have been put nder various races of jute on the Dacca farm for the production f pure seed to be distributed next year.

II.—FLAX.

Experiments at Dooriah.—This crop continues to be culti- ıted at Dooriah, Behar, on a considerable scale; but although ɜarly 40 acres were devoted to flax in the *rabi* season of 1909-)10, the experimental stage can hardly yet be said to have been ιssed. Last year's results, while indicating that the lower lands *'handhar*) are likely to prove most suitable, owing to the better pply of moisture, also tend to emphasise the necessity for high ltivation. Such lands which had been treated with indigo fuse yielded an average weight of nearly 54 maunds of excellent :aw per acre. On the other hand, from similar land not directly ınured rather less than 30 maunds per acre was obtained. The :aw will yield fully 10 per cent. of fibre worth £50 or more per n; so that the gross outturn on the manured plot was increased manuring to the extent of nearly Rs. 60 per acre. Such a sult indicates the necessity for careful investigation of the ques- n of manures, and as there is at present no suitable land for the rpose on the Dacca farm, the Inspector-General of Agriculture India has kindly offered facilities at Pusa for a comprehensive ·ies of experiments, and has also given his advice in the draw- ; up of the scheme.

Experiments at Pusa.—The main object of the experiments th flax at Pusa during the season 1909-10 was to obtain in- ·mation regarding the yield of straw to be expected from ɜrage good soil which had not been speciall-

for the crop. The land on which the experiments were carried out was high and rather light in texture; but it was in good condition and owing to the abnormal monsoon, the soil moisture was fairly good throughout. A yield of nearly 54 maunds of good straw was obtained from one and-a-half acres, representing 35 maunds per acre. Although this yield is satisfactory, yet the crop showed indications of distress at one time and the conclusion to be drawn is that in an ordinary moisture year, good results could not be expected from such high land unless irrigation were resorted to.

Further information was obtained on the subject of acclimatised seed, which indicates that new seed should be imported at least every two or three years if the quality of the fibre produced is to be kept up. As flax seed imported from Europe costs about Rs. 15 to Rs. 20 per maund, preliminary trials have been commenced in some of the cooler hill tracts of India with a view to investigating the possibility of surmounting this difficulty. As might be expected, no definite information has as yet been obtained; it is necessary first to ascertain the period of the year which is most suitable to the growth of the crop. Definite trials with this end in view are being carried out in the Shillong district by the Deputy Director of Agriculture, and seed has also been sent to Kashmir and to Ootacamund.

The Importation of Flax Seed from Europe.—In last year's report, reference was made to the fact that flax seed cannot be imported safely into India during the hot weather and the rainy season, unless special precautions are taken to dry the seed before despatch and to keep it from absorbing moisture during transit. Our experience has been that no special precautions are necessary, if the seed is despatched from Europe so as to reach India during the cold weather season. The total cost of importation under these conditions is from Rs. 15 to Rs. 20 per maund. If, however, the seed arrives during the hot weather, or in the rainy season, it is necessary to dry it very thoroughly before despatching and also to pack it in hermetically sealed tin-lined boxes:

extent that it refuses to germinate on arrival. A large consignment of flax seed was actually imported in tin-lined boxes during the rainy season a year ago and the bulk of it was good; but its total cost approached Rs. 30 per maund. Such a price for seed means a very serious increase in the working expenses of a crop, the seed rate for which is over one and-a-half maunds per acre.

Flax in Assam.—Mr. H. J. Lawrie of Baihata, Kamrup, made a preliminary trial with flax during last season, but although the straw was of good quality, the land on which it was grown was too high and the lack of soil moisture affected the yield adversely. It is hoped to continue the experiments this year under better conditions.

United Provinces.—Last season an excellent crop of flax vas grown under irrigation on a demonstration plot at the Agricultural College, Cawnpore. The weight of straw, the uality of which was very good indeed, corresponded to 40 naunds per acre. Further trials are contemplated for the oming season.

Central Provinces.—A small plot of flax was grown last ear under irrigation at Hoshangabad and produced straw of ir quality. It is proposed this year to carry out trials on the nseed growing lands in the Jubbulpore District and also in the agpur District.

Extraction of Fibre from Desi Linseed.—Several attempts ve been made to extract fibre from the stems of ordinary seed; but although linseed and flax are botanically identical, e two plants differ so greatly in their natural habits that very tle success has hitherto been met with. While the straw of od flax is smooth, unbranched and flexible, the stem of ordinary seed is generally rough, woody, brittle and often very branched. e fibre which can be extracted from such stems is not only y small in quantity; but it is also so inferior in quality as to almost worthless. Last year, however, one crop of *desi* seed grown on heavily manured land under good moisture ditions showed a distinct improvement in the quality of the w, which weighed nearly 40 maunds per acre, while th...

obtained approached three times the quantity produced by the imported flax. The experiments will be repeated.

Conditions necessary for the successful Cultivation of Flax.—The following points in connection with the cultivation of flax are tentatively regarded as having been elicited from the experiments so far carried out in India.—

(1) Land selected for flax should contain an abundance of moisture both at the time of sowing and throughout the period of growth of the crop. If these conditions cannot be secured by natural means, irrigation may be substituted without detriment.

(2) Lands of the lower type such as *Dhandhar* are eminently suitable, both on account of the nature of their soils and also because the moisture supply is less likely to be precarious. There is, however, no doubt that flax will do well in high lands of good quality, provided the texture is not too light and that a sufficiency of moisture is secured.

(3) Sowing can usually be done successfully between October 20th and November 13th.

It would appear that the crop requires roughly 100 days to mature; so that reaping would take place from about the beginning of February to the beginning of March according to the date of sowing.

NOTES.

THE COPPER BLIGHT OF TEA.—This disease was found recently on dried leaves from the Dooars and is probably identical with a blight previously observed in Assam. The first symptom is the appearance of a small copper-coloured spot on the upper surface of the leaf, this spot is irregular in shape and the margin is not very clearly defined, the copper colour gradually passing into the green of the leaf. The surface of the discoloured patch is covered with very minute black spots, which on microscopic examination prove to be areas in which the peripheral leaf tissue has disintegrated, leaving a small crater-like depression. In later stages the discoloration extends right through the leaf appearing as a yellowish brown patch on the under surface, at the same time the copper-coloured area on the upper surface takes on a grayish colour while the margin of the patch becomes sharply defined. The diseased portion of the leaf is now very brittle and is often traversed by numerous cracks.

Detailed examination showed that the black spots in the younger stages were due to the presence of the pycnidia, or spore-cases, of a fungus, situated just below the epidermis of the leaf. They are rounded structures with a very minute aperture at the apex, and consist of a black outer wall of fungal tissue enclosing a central cavity filled with spores. When mature the upper portion of the wall of the pycnidium together with the leaf tissue immediately covering it is thrown off, leaving the lower portion as a crater-shaped cavity full of spores. The pycnospores are oval hyaline structures, each surrounded by a mucilaginous outer coat and with a mucilaginous tail developed at one end. In the older grayish stages of the disease another

type of spore-producing organ was found associated with the pycnidia described above. This second fructification or perithecium is the fruiting stage of the Ascomycetous fungus *Laestadia Theae* Racib, which has previously been described as causing a leaf disease of tea in Java. Both a pycnidial and a perithecial fructification essentially similar to the above have also been described as belonging to another species of Laestadia (*L. Vaccinii* Shear), which causes the scald of Cranberries. The connection between the pycnidial and perithecial stages is not in this case absolutely established, but there is at least a strong probability that they are simply different stages of one and the same fungus.

Thus in the only other case known in which pycnidia with the characters described above occurred, they were associated with perithecia of Laestadia. The presumption is as strong as it can be in the absence of adequate cultural experiments that the disease which we have called "Copper blight" is due to the presence of the fungus *Laestadia Theae* Racib at first in the pycnidial and later in the ascigerous stage.

The blight is described as spreading with extreme rapidity; at present it attacks merely the older leaves, probably the rapid spread takes place in the pycnidial stage when large numbers of spores are produced. Plucking off and burning the diseased leaves would decrease the spore production and lessen the chance of infection, but this may not be practicable. Spraying with Bordeaux mixture has been used with success in the case of Cranberry scald and particularly in the case of Black Rot of Grapes, a disease due to another species of Laestadia, it might be beneficial here. In the case of the Java outbreak the disease does not appear to have caused sufficient damage to necessitate preventive measures. In Assam there seems to be some connection between the climatic conditions and the occurrence of the disease, warm sunshine after heavy rain, such as occurs in April, being followed by the appearance of the blight. In this connection it is interesting to notice that the allied disease Black Rot of Grapes is known to be closely dependent on weather conditions.—(F. J. F. Shaw).

An Agricultural School in Sind.—A step in advance has been made in Sind by the proposal to establish an agricultural school for young men between 16 and 21 years of age of the cultivating class. The purpose of the school may be best learnt by the following extract from a letter of the Director of Agriculture, Bombay, published in a Resolution of the Government of Bombay :—

"I have the honour to forward copies of No. 4345 of 8th November 1909, from the Commissioner in Sind to this office, with accompaniments, No. C-112 of 10th January 1910, from this office to the Commissioner in Sind, and No. 760 of 7th March 1910, from the Commissioner in Sind to this office.

"2. From this correspondence it will be seen that there is a proposal to start an Agricultural School in Sind for young men of the cultivating classes, the circumstances which led to the proposal being made will be appreciated and the character of the proposed school understood.

"3. In this connection I may mention what is being done in the Presidency proper in the way of agricultural education.

"We now have—

(*a*) A three years' degree course at the College.

(*b*) A one year's practical course in English given at the Agricultural College to young men who wish for such instruction to fit themselves for cultivating their own lands.

(*c*) A two years' vernacular course at the school just commencing work in Poona for the sons of *patels* and substantial landholders, limited to boys of about 14—15 years of age who have passed their 4th vernacular standard. At this school in addition to the agricultural instruction some instruction in reading, writing and arithmetic will be given.

(*d*) Short courses on the farm. These are given in particular subjects (*e.g.*, seed selection) at the season which suits. It is now proposed to systematise these short courses and advertise them.

"4. The proposed school for Sind will be something between (*b*) and (*c*) mentioned above. The course will be given in the vernacular, will last 18 months and will be essentially agricultural; it will be mainly practical, but will include sufficient theory to enable the boys to understand the practice taught. The age of the students selected will probably be about 16 to 21; and the students will be selected from the land-holding and cultivating classes. It is expected that the students will be fitted—

(1) to improve the cultivation of their own lands;

(2) to manage estates for zemindars;

(3) to serve in the Agricultural Department.

"5. If the school is started on a modest scale for (say) eight students, the probable expenditure would probably be as follows :—

Initial.

		Rs.
1.	Buildings	5,000
2.	Live and dead stock	1,000
	Total ...	6,000

Recurrent.

1.	Pay of master	720
2	Subsistence for eight boys at Rs. 10 per mensem	960
3.	Miscellaneous	320
		2,000

"6. As the school expanded fresh quarters would be required, the pay of the master would increase, and the addition of a second master would be necessary ; but it is possible that some of the Local Boards might be willing to finance students of their own selection, which would save further expenditure in that direction. It is also possible that some students might be found who did not require maintenance allowance.

"7. There are no surplus funds at my disposal which will enable me to start such a school this year; but if Government approve of the idea a syllabus of instruction will be prepared, an agricultural graduate put into training for the post of master, and provision will be made for the school in the budget proposals of this Department next submitted. The school could in that case be started in April next, or at an earlier date if the money can be provided by Government in the meantime."

"*Resolution.*—The proposal to start an Agricultural school in Sind is approved. The Director of Agriculture should be requested to make the requisite provision in the budget estimates for 1911-12. The provision should be subject to reconsideration when the budget is settled, and should be treated as optional."

It is to the credit of the Bombay Agricultural Department that it has the courage thus to face circumstances and forge the links that are missing in the chain which has to connect the Provincial Agricultural Colleges with the cultivating classes. We want more of these schools all over India to make feeders for our colleges.—(EDITOR.)

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THE CASTILLOA SCALE-BUG AND ITS DANGER TO TEA.—In the August issue of the *Tropical Agriculturist,* Mr. Ernest

Green, Entomologist to the Ceylon Government, has an interesting and informing note on his discovery of a new scale-bug *(Inglisia sp.)*, infesting the Castilloa rubber tree. The matter is of importance not only to growers of the *Castilloa elastica*, but to tea planters who have Castilloa in or near their plantations or are contemplating laying down this variety of rubber, for the pest appears to as easily infest tea bushes as the rubber plant. On a visit very recently paid by Mr. Green to a five-acre clearing of 7½ year old Castilloa trees, he found they were completely overrun by the bug and that not a single tree has escaped infection.

Mr. Green states that the original source of infection remains undiscovered and that it is improbable that it could have been imported with living Castilloa plants. It is a new and hitherto undescribed species of scale-bug and—as far as is known—this is the only locality in which it has appeared.

It would seem that it is a much more serious matter for the tea plant than for Castilloa, for the latter has not been found very profitable in Ceylon, and it would appear advisable to sacrifice it for the sake of the tea. If the pest is allowed to establish itself, Mr. Green opines, it will prove a very dangerous enemy to the tea plant.—(EDITOR.)

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THE AUTOMATIC WATER-FINDER.—This is a simple apparatus supplied by Messrs. Mansfield and Co., of Liverpool, by which any unskilled person may readily ascertain whether a subterranean spring of water exists under a spot where it is desired to sink a well. It indicates the presence of subterranean flowing springs at depths up to 1,000 feet.

To quote from the makers' prospectus, "the principle on which the instrument works is the measuring of the strength of the electrical currents which are constantly flowing between earth and atmosphere, and which are always strongest in the vicinity of subterranean water-courses, the flowing waters of which are charged with electricity to a certain degree. Should

a subterranean spring be present under where the instrument has been fixed, the needle commences to move.

* * * * *

If the needle remains stationary, it may be taken for granted that a subterranean spring does not exist under the spot where the instrument is fixed."

The instrument has been tried by the Bombay Department of Agriculture in the trap areas of the Deccan, where underground streams traverse the country in various directions. Mr. H. K. Mehta, M.A., B.SC., of the Poona Agricultural College, was specially put on to this work, and in Bulletin No. 38 of 1910 of the Department of Agriculture, Bombay Presidency, will be found a detailed account of his investigations, during the first five months of 1910. Dr. H. Mann in a preface states that "the results so far obtained, though not absolutely conclusive, indicate an almost certain success. Where wells have failed no indication has ever been found: where successful wells exist, indications are always found; where continuous underground streams are, for other reasons, supposed to exist, the instrument confirms their presence: and where a stream passes near a well so that percolation may be presumed to take place, that percolation is actually found." Dr. Mann is careful to warn us that complete proof must still be awaited, but still Mr. Mehta's experiments would seem to justify the statement that we have come to within measurable distance of a water-finder, whose construction and action are based on scientific principles. There are, however, certain difficulties in the way, such as expense and delicacy in the instrument for details of which the reader is referred to the Bulletin.—(EDITOR.)

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HOW SUGARCANDY IS MADE IN SIND.—In a large iron pan (*Kadhai*), is placed about 20 lbs. of sugar and to it is added 10 lbs. of water. The pan is placed on the fire and all the suspended impurities are removed. Just before boiling half a pound of milk is added to help the separation of dirt and other impurities, which are removed as soon as they come to the surface.

When the syrup becomes clear, the fire is increased gradually and it is boiled till it gets to a particular consistency which can be easily recognised when once seen. Then an earthen vessel, big enough to contain this syrup and which has been kept in water for three days, is taken and on its mouth reed or bamboo splints are spread horizontally and parallel to one another. From these, threads are hung, the other ends of which are secured to the bottom of the vessel by paste made from wheat or rice flour. The syrup is poured into this vessel and kept till the crystals form. It takes about 3 to 6 days according as the temperature of the locality is high or low. After this period, the uncrystallisable liquid is removed and the vessel is kept in the sun for a short time. When dry, the pot is broken and a lage lump of crystallised sugar is taken out. The strings serve as aids round which the crystals first aggregate.—(G. S. Kulkarni.)

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Potato Disease on the Nilgiris.—Owing to a serious outbreak of potato disease in the Nilgiris, Mr. W. McRae, M.A., B.SC., Mycologist to the Government of Madras, was deputed to make an investigation of the same and advise as to its treatment. The following extract from his recent report will be of interest :—

"For a considerable number of years disease has been prevalent in the potato crop in the Nilgiris. The cultivators know the diseases quite well but, being ignorant of the cause and the method of spread, exercise only the crudest methods of avoiding them. Hitherto only two potato diseases have been reported from this district—

(1) Irish Blight.

(2) Bangle Blight, otherwise ring disease or *bangadi.*

In the month of May in Ootacamund, there was no sign of the former disease though much of the latter. This is not anomalous, as Irish Blight is a late blight and the crop was in the early part of its season. Another Blight was also common. It is identical with the American (3) Early Blight and has hitherto been reported in India only from the United Provinces. Like Irish Blight, it attacks the leaves and the two have been confused since more than one European showed it to me as Irish blight. It is more common at this time of year than Bangle Blight.

Occurrence of the three Blights.—Irish Blight occurs in nearly every country where potatoes are growing. It is said to have been in the Nilgiris for many years. *Early Blight* is well known in North America where it does considerable damage, and in Western and Central Europe where it does a fair amount. It occurs also in Australia, New Zealand and South Africa. It was reported from the United Provinces in 1903. This is the first time it has been reported from the Nilgiris. *Ring Blight* has been a long time in the district. It was reported from the Nilgiris in 1892 by Capel. It occurs also in India in Bombay, Bengal and Mysore. It is known in Europe, America, Australia and New Zealand.

Symptoms.—A short note on the symptoms will now be given—(1) Irish Blight may be omitted as it was not seen in May.

(2) Early Blight is confined to the leaves and stems. It begins to show about the time the young tubers are beginning to form. On the leaves, small light-brown spots with well-defined edges appear, and gradually increase in size and deepen in colour. Faint concentric lines mark the successive edges of the spot, and this is a mark easily distinguishing Early Blight from Irish Blight in which the spots are not so marked and the edges of the spot are not so clearly defined. These spots, too, become rather brittle and dry, instead of soft and foul-smelling as in the Irish Blight. The spots gradually spread over the leaf surface till the leaves succumb. The stems too may be spotted. Ultimately the whole shoot perishes. No signs of the disease getting into the tubers were noticed. What seems to befall them is that they remain small and fail to reach maturity, because the ærial shoot is weakened and killed before it has produced enough good material for the development of the tubers.

(3) *Ring Blight.*—The symptoms are the same as those described by Coleman in Bulletin No. 1 of the Mysore Agricultural Department. Individual plants and little groups of plants show signs of flagging and wilt suddenly. On digging up and slicing the tubers of the affected plants, small, dark, discoloured spots may be seen forming a ring just within the periphery in the region of the vascular bundle ring. A section across the collar of the stem shows a similar discolouration. Under the microscope, the water-conducting tubes and adjacent cells are seen to be filled with masses of bacteria. These choke up the water-conducting tubes and cut off the supply of water to the green leaves which immediately droop and hang down, just as cut flowers do, if not placed in a vessel of water.

Spraying.—Any treatment that may be suggested can only be preventive not curative. When once a plant has been attacked nothing can save it. In other countries potatoes have proved to be one of the crops most amenable to treatment for disease. In all western potato-growing countries, spraying has become a routine operation in those districts where disease is severe. For two of the diseases reported to occur in the Nilgiris (Irish Blight and Early Blight), spraying has been found most efficacious, though for the third (Bangle Blight) it is of no use. Bordeaux mixture (4-4-50) applied, when plants are four to six inches

high, *i.e.*, just before Early Blight is expected to appear, and repeated at intervals of a fortnight till five or six treatments have been given, is the fungicide most useful. This treatment would be applicable for the second or autumn crop, but for the first or monsoon crop, I am doubtful. In the latter case, the first application would be given early in May and the others successively till the end of July. The character of the monsoon rains would probably render spraying useless by washing off the spray from the leaves. It is not expected that spraying will be introduced among cultivators now. Some of the European cultivators whose crops are badly diseased would find it worth their while to spray. Later on the smaller growers might take to spraying when they saw it paid. A simpler type of sprayer than those of the market at present might be evolved suitable for the work.

Field Sanitation.—Collecting and burning all stalks and leaves and carefully removing all small or rotten potatoes from a diseased field, so as to avoid their rotting on the ground and carrying on infection from one crop to another is a *sine quâ non* before the slightest improvement can be expected. Now the cultivators leave the vines and the bad tubers on the ground to decay, because they do not understand how the disease is carried. Unless this is thoroughly attended to, it is useless to do anything to combat disease.

Seed.—Diseased tubers should not be utilised for seed. It is not always possible to tell by the naked eye whether a tuber is diseased or not, hence seed should never be taken from the produce of a diseased field.

Rotation.—The expense of enclosing the ground is so considerable and the crop is so profitable that it is grown in both seasons year after year in the same land and the unwillingness of the cultivator to rotate it with less valuable produce, even when disease is severe, is one of the chief difficulties to be met. Such a practice is bound to break down the constitution of the potato and to produce a weak crop susceptible to disease. If Bangle Blight has been severe on a field, the ground should have a rest from bearing potatoes for at least one year, and perhaps more may be necessary, as the bacteria live in the soil certainly for one year. Oats and barley are grown to some extent in the hills and though not bringing the return of a potato crop are still valuable enough to form a rotation crop with it.

New Seed.—The importation of new varieties should be encouraged. At the present time, however, potatoes from Europe ought to be treated with suspicion because of the wart disease (*Chrysophylictis endobiotica*) which, during the last few years, has spread rapidly over England and the Continent of Europe and has reached Newfoundland. The Australian Colonies and New Zealand are suitable places from which to get new seed and a guarantee may be had with the seed stating that it is free from disease. Mr. G. Oakes last year introduced three such varieties from New South Wales. They were guaranteed disease-free and on testing in new soil proved to be so. Now they want to be tested for disease-resistant quality.

Disease-resistant Varieties.—A disease-proof variety is an Utopian idea. A more or less disease-resistant variety may be evolved by continuous selection of varieties grown in a diseased locality. If introduced varieties and the best of the varieties now in the district were grown in badly-diseased land, they would be found to differ greatly in their susceptibility. The produce of the few disease-free plants would be carefully selected each season and used as seed for the succeeding season. This process would be repeated for several seasons. From one or more of these varieties it would be possible by selection in this way to evolve a potato that was resistant to disease. Coleman has been doing this for some time in Bangalore against Bangle Blight and his experience will help us. It has been found that a variety resistant to a disease in one locality may not show that resistance in another locality and it is probable that disease-resistant varieties will have to be evolved in the Nilgiris for the Nilgiris. Loss of resistance in a potato occurs after a few years' cultivation: hence, constant attention is required to keep up a good standard of cultivation and the seed should be continuously selected. There is no official means of doing this in the Nilgiri district. The Collector is keen and Mr. G. Oakes and a few others are interested, and as far as I can see, it must be left to private enterprise.

There is no doubt that the problem of reducing disease among potatoes in the Nilgiris and keeping it under control is a difficult one. Under the present system of cultivation, everything is done to favour the introduction of disease and to foster it, once it has come. But by paying attention to field sanitation and the choice of seed, by the introduction of a rotation and by the propagation of resistant varieties, the losses due to disease may be largely overcome.

To sum up—

(1) These are the common diseases to be guarded against:—

Irish Blight.
Early Blight.
Bangle Blight.

(2) Contaminated seed is being used. Diseased tubers should not be used as seed, and seed should not be taken from the produce of a diseased field.

(3) Two potato crops are grown year after year on the same field. Rotate with oats or barley or any other crop, but not with brinjals nor tomatoes.

(4) The vines as well as small and diseased tubers are left in the ground to carry on disease from season to season. Crops should be carefully lifted and no tubers left in the ground. The vines and rotten diseased potatoes should be carefully collected and burned.

(5) The bacterium causing one of the diseases (Bangle Blight) lives in the soil for more than one year. When this disease is prevalent in a field, rest the soil for at least one year by leaving it fallow or by rotating.

(6) Disease is accumulating year after year. New varieties should be introduced and tested. These, as well as good varieties already in the district,

should be selected and those that prove to be resistant, put on the market. This should go on continuously so as always to have a new variety coming on, when the disesae-resistant powers of those on the market break down."

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FIBRE CONGRESS AND EXHIBITION IN JAVA.—In July 1911 under the auspices of the Netherlands Indian Agricultural Association, and assisted and patronised by the Dutch Government, a Fibre Congress and Exhibition will be held at Sourabaya in Java. The aims of the Congress and Exhibition are :—to further the cultivation of fibre plants in the tropics, to advise planters regarding their culture, to discuss points on which there is now difference of opinion, to attain uniformity in methods of production and in products, and to arrive at a proper insight as to the value of cultivating fibre plants both on a large and a small scale. The consideration of cotton, it is reported, will be excluded.

The Congress and the Exhibition will be opened on the 3rd July 1911, by the President of the Netherlands Indian Agricultural Association and will be closed on the 8th idem. The second day will be devoted to discussing the cultivation and preparation of the Agave fibres, especially sisal hemp, and the third, to Manila hemp and jute and the substitutes for the latter. On the 4th day the cultivation and preparation of Kapok and pine-apple fibres will be discussed. On the 5th day the trials of fibre extracting machines will be held, to give the visitors and planters an opportunity of judging their merits. The sixth and the last day will be devoted to the discussion of points relative to the productiveness of the cultivation of fibre plants, the presentation of diplomas, etc.

The Congress and the Exhibition ought to prove of great value to those who are now interested in the extension and cultivation of fibre plants in India.—(EDITOR.)

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WILD INDIGO (TEPHROSIA PURPUREA; TAMIL, *Kolinchi*; TELUGU, *Vempali*) AS GREEN MANURE FOR PADDY LANDS.—Wild indigo is an erect shrub growing up to 3 feet in height and 3 feet in diameter at top. The plant belongs to the family of pulses and

is recognised as one of the best green manure crops there is in the country. It has a long tap root which strikes on plant food from the deeper layers of the soil and is a means of improving the texture and the moisture retaining quality of the land. It possesses the power or means of absorbing nitrogen from the air.

The plant is generally found on high level waste lands, plains, and fallow lands which are fairly loose in texture. It is keenly sought after for manure during the cultivation season when it is spread and trodden in the land which has been puddled for the sowing or transplanting of paddy. It is carried in carts or as head-loads at a great cost to distances varying from 1 to 50 miles; a half-ton load, costing Rs. 3-8 at Sivagiri, costs Rs. 10 at Ambasamudrum which is 45 miles away. Under these circumstances there arose a question as to why, when the plant grew on certain lands, it should not be grown on similar lands on which it could be directly used as manure without the expense and trouble of collecting the leaf from long distances outside. Accordingly, experimental sowing of the seed on a large scale was first started at Sivagiri in the Tinnevelly district with very successful results, and it has now become a common practice to collect the seed for sowing and sale in the locality, as it has been thoroughly proved that with a couple of ploughings and a few measures of seed one to two tons of green manure can be easily produced on the spot.

The Agricultural Department is taking much interest in spreading the practice also in other districts by purchasing the required quantity of seed at Sivagiri. During the present season the Department purchased 200 bags or more than 14 tons of seed for the district of Tanjore alone.

The seed should be first sown on the land at the rate of three Madras measures or 10 lbs. per acre and then covered with one or two ploughings, as is generally done in the case of pulse crops.

It may also be sown along with gingelly as a mixture when it thrives and forms a good green manure after the harvest of gingelly. When sown under favourable conditions a good portion of the seed germinates within about a week, the remaining portion sprouting in batches at different times later on. The chief pecu-

liarity of this seed is that it lies dormant in the soil for even a year without losing its vitality. There are several instances in which the seed did not germinate the first season it was sown, but yielded a satisfactory green manure crop after the succeeding crop of paddy had been harvested, the seed lying dormant in the soil throughout the period the paddy crop was occupying the land.

Occasional showers help the crop to come up well, but continuous heavy rains producing water-logged conditions even for a day would kill it, especially a young crop. The crop should therefore be sown at the end of the rainy season. After five or six months' growth it can be ploughed in and applied as green manure for the succeeding grain crop.

Single-crop-wet lands under tanks and canals will be immensely benefited by growing this crop instead of allowing them to lie waste and weedy for about 6 months in the year.

It is a known fact that the generality of ryots are now unable to provide sufficient manure for all the land they hold and this, sooner or later, must have a serious effect on the yield of their crops. The best advice, therefore, is to grow a green manure crop during the period the land lies empty in order to increase or at least maintain the fertility of the soil.

As goats and cattle do not relish wild indigo there is no fear of the crop being destroyed by stray animals.

This crop will not grow on the stiff and saline soils, but even these are known to bear a crop of wild indigo when improved by continuous and heavy applications of tank silt, sand, and leaf manure, obtained from outside.

If the organic matter in the soil could be sufficiently increased by persistent growing of green manure crops, the land in course of time becomes sufficiently loose and retentive of moisture to allow the wild indigo crop to come up well from the self-sown seed without even the necessity of ploughing after the harvest of paddy.

Wild indigo can also be sown on dry land as a mixture with gingelly or with the final hoeing of other crops. In this case also it can be applied as manure by being ploughed in either standing or after being cut and spread on the land.—(A. RAMA RAO.)

REVIEWS.

DRY-FARMING: ITS PRINCIPLES AND PRACTICE. BY WILLIAM MACDONALD, M.S. Agr., SC.D., Ph.D., FOREIGN VICE-PRESIDENT AND CORRESPONDING SECRETARY FOR THE DRY-FARMING CONGRESS. (T. WERNER LAURIE, LONDON.)

As stated in the preface, the aim of this volume is to set forth in a plain way the salient facts of that new branch of agricultural science which is now known as dry-farming. It will well repay perusal by any one interested in the agriculture of arid or semi-arid regions in which India is included. Dry-farming is defined as "the conservation of soil moisture during long periods of dry weather by means of tillage, together with the growth of drought-resistant plants." It is not of course farming without moisture, for that would be clearly impossible. The phrase is now loosely applied to a particular form of farming in all places where the rainfall ranges from zero to 30 inches per annum. It is, however, much more a question of the distribution of a limited amount of rainfall than any total amount per annum. Thus, while 30 inches of rain well distributed throughout the year in some countries would require no particular efforts on the part of the farmer for conserving the moisture, if this same 30 inches all fell in three months of the year leaving practically a rainless period of nine months, considerable ingenuity would be necessary to conserve the moisture and grow crops during that latter period.

In India, the subject of dry-farming is of considerable interest, but it should be noted that the practice is already not unknown. Indeed, the *Rabi* crops of the cold weather months have to be grown on the moisture supplied by the often scanty

three months' rainfall of the monsoon. The Indigo Planters of Behar, before the introduction of Java indigo plant which is sown in September, depended entirely on the moisture of the three months rain in the monsoon on which to sow and germinate their indigo crop in the following March. The methods they adopted during that period of practical drought from October to March were with a view of conserving the moisture of the soil. They not only included deep digging and ploughing, but also the closing and pressing down of the soil so that the moisture from below might rise to the surface, the keeping clean of weeds and the breaking of the surface and formation of a mulch whenever a crust was formed by unexpected rain. So too the native cultivator in regions where the rainfall is barely sufficient, or the physical nature of the soil renders it unretentive of moisture, uses methods of tillage and sowing which may rightly be classed as belonging to the process of dry-farming. While, therefore, it has perhaps been reserved to America to work out the principles underlying dry-farming, I venture to think, the practice, so far as India is concerned, is of some antiquity. Yet it is only by knowing and understanding scientific principles and the experience of others that progress and improvements can be achieved so that the Indian Agriculturists may well learn from their brethren in America. In that country in tracts where the rainfall is markedly deficient, not only is tillage and the growth of drought resistant plants resorted to but the holdings are of such a size that the farmer is enabled to place one portion under treatment without crops for a whole year with the sole object of preserving the moisture, another portion under crops and a third in pasture for his stock. The proportions are usually one quarter in fallow, one quarter in crops and one half in pasture. It is, therefore, possible that one of the methods which might, with advantage, be tried in India, where lands are at present uncultivated and considered unprofitable for want of sufficient moisture, is to give out to cultivators holdings four times the usual size. The characteristics in dry-farming on which stress is laid in America are (*a*) a deep initial preparation of the land, (*b*) constant

shallow after-cultivation, (*c*) fallowing the land every other year, where rainfall is generally deficient, (*d*) the growth of drought-resistant crops, (*e*) restricting the number of crops to a few staple crops such as wheat, barley, etc., and (*f*) placing half of the whole holding under pasture for stock. An important matter, however, must be noted that all soils do not lend themselves to dry-farming and therefore, the most important factor in the whole of this subject and one which must be ascertained before anything else is done, is the nature and quality of the soil. The soil should be looked upon as a reservoir for the storage of water over periods ranging from a few weeks to many months. Those which retain rainfall best are sandy loams having a supply of well decomposed vegetable matter. Clay soils are unsuitable, as the moisture does not rise fast enough to supply the plant during spells of very dry weather. Soils known to be poor in lime should be avoided or supplied with the required lime. Naturally, poor soils can be greatly improved and made good dry-farming soils by green manuring or the application of farm-yard manure, but the application of commercial fertilisers is seldom of much practical benefit to the dry-land farmer who needs more a moisture-retaining soil rather than a temporary artificial stimulant to plant growth.

Mr. Macdonald has rendered a great service by placing within reach of any interested in the cultivation of arid land such a complete and clear statement of the principles and practice of dry-farming, and it is to be hoped that members of the Agricultural Department interested in the subject will make use of the useful information he supplies.—(EDITOR.)

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FOURTH ANNUAL REPORT OF THE COMMITTEE OF CONTROL OF THE SOUTH AFRICAN CENTRAL LOCUST BUREAU. (CAPE TOWN.)

THE Central Locust Bureau of South Africa was formed in 1906 to collate reports from the various Colonies of South Africa regarding locusts, mainly their occurrence and movements, in order that, over the whole area, measures against them could be

correlated and the best methods of procedure should be widely known. The British Colonies contribute to the cost as do also German South-West Africa and Portuguese East Africa. Every month the Bureau issues maps showing the occurrence of locusts over the whole area, and these are, at the end of the year, united to form this report. It is probable that the work of the Board will devolve upon the Department of Agriculture of the Union Government.

There are, in South Africa, two locusts, neither occurring in India. Their occurrence varies from year to year, and the year 1909-10 was marked mainly by their comparative absence. One species occurred scarcely at all in British territory and hoppers were found only in Mozambique and in Natal, the cost of fighting them in the last being under £50. The second locust occurred lightly in German South-West Africa, seriously in the Orange River Colony and the Cape Colony, enormous swarms having come in from the Kalahari Desert. A strip of country 200 miles wide was infested and enormous swarms of hoppers hatched. These were destroyed vigorously and the country was practically cleared of locusts. They anticipate a few years' freedom from the pest. Practically the sole remedy used is the application of a strong solution of arsenic with sugar to the vegetation the hoppers are about to eat. This solution is issued ready made and about 12,600 gallons were used. There were a few cases of stock poisoning due to gross carelessness in the use of the mixture. In the Orange River, the mixture is not sprayed direct on to the growing vegetation but succulent green fodder is cut, poisoned and laid out for the hoppers.

It is an extremely instructive thing to realise how little danger there is in the use of arsenical poisons in this way; the method used has been tried in India and abandoned on account of its supposed danger. Yet here is another year's experience under very similar conditions in South Africa and they report successful use of the method. In India, the use even of very dilute non-soluble arsenical poisons such as Lead Arseniate is, by the ordinary man, looked on with horror and the use of

insecticides generally is almost unknown.' Our locusts are very different to those of South Africa and the poisoned bait-method could scarcely be used, but it is as well to realise that over large areas of land they use freely a solution containing twelve times as much arsenic as in an ordinary spray for crops.

The Locust Bureau and the territory they work over are to be congratulated on the success they have attained and the very solid work done. The report affords interesting reading, is well illustrated, and the maps are most valuable.—(H. M. Lefroy.)

JAINDHARA DISEASE OF GINGER – HEALTHY AND DISEASED

THE INFLUENCE OF BACTERIA UPON SOIL FERTILITY.

By C. M. HUTCHINSON, B.A.,

Imperial Agricultural Bacteriologist.

Previous to the introduction of the science of soil bacteriology the laboratory examination of soils had been mainly directed to the discovery of the causes of their relative fertility by methods depending upon the determination of their chemical and physical constitution. Chemical analysis has told us much as to the plant foods present or wanting in soils, and has suggested the use of artificial and other manures in the field ; mechanical analysis has shewn the necessity for taking into consideration the texture of the soil as a prime factor in producing fertility, but neither of these methods can provide full information as to the multitudinous and complex changes going on in the soil, the sum of which results in the production of available plant food. The importance of the biological factor has been more fully realized in recent years, and the object of this paper is to give an outline of the methods which may be adopted for determining the constitution of the soil complex and its relation to fertility.

The point to be kept in view is not so much the mere making of a biological analysis of a soil as the determination of its response to cultivation, to irrigation or drainage, or to application of manures, whether organic or otherwise, such determination being based upon the following considerations. A normal soil contains bacteria which may be roughly divided into two classes so far as fertility is concerned (1) beneficial, (2) detrimental. Fortunately the beneficial kinds predominate in the large majority of cases, and for our purpose it will be sufficient to indicate the part they play in producing fertility.

The beneficial bacteria may be sub-divided according to their functions in the soil :—

(1) Those which attack organic matter or soil humus and convert its nitrogen into ammonium compounds.

(2) Those which produce nitrites from these ammonium compounds, and those which further oxidize the nitrites to form nitrates.

(3) Those which bring atmospheric nitrogen into combination as organic compounds, thus increasing the supply of this element in the soil.

(4) Those which attack and break down organic matter in the soil but do not necessarily produce ammonium compounds, their action being beneficial as resulting in the disintegration of vegetable tissues which are consequently more readily attacked by ammonifiers.

Now the presence of these various classes of micro-organisms in any sample of soil may be determined by appropriate methods which allow of their separation and identification, and even of calculation of their numbers, so that it might be supposed that by the use of such analytical processes definite information as to the relative fertilities of soils might be obtained so far as their bacterial content was concerned. Now this is unfortunately an impracticable method, not only on account of the extremely tedious and laborious work involved, but also because of the impossibility of integrating the individual results with any probability of arriving at a true statement of their sum. Other simpler and more reliable methods are therefore utilized to determine the biologic activity of a soil, and I hope to show not only how this is measured directly, but by what means an estimate may be obtained in the laboratory of the probable value of various agricultural operations when applied to the soils under examination.

As pointed out above, the object to be kept in view is the response of the soil to various agricultural operations, and it would be well to formulate these in conjunction with their effect upon the condition of the soil and the probable modifications in the bacterial content resulting therefrom.

1.—Tillage Resulting in Increased Aëration.

The activity of practically all beneficial bacteria is increased by this means; the breaking down of vegetable tissues such as roots, stubble, green manures ploughed in, and cattle manure is dependent upon sufficient aëration of the soil, and so, to an even more marked extent, is the final process of nitrification.

2.—Irrigation and Drainage.

These two complementary procedures are intended to regulate the water content of the soil, primarily for the supply of moisture to crops, but the maintenance of the optimum amount of water is also vital to the action of beneficial bacteria; shortage of water produces cessation of their activity, and excess, or water-logging, not only has the same result but encourages the action of certain detrimentals, notably those denitrifiers which are responsible for the losses of combined nitrogen which take place under these conditions; aëration is also dependent upon a proper regulation of the water-supply.

3.—Manuring.

Although all cultivated soils contain bacteria, the number of these which are found varies enormously in accordance with certain factors such as water-supply and temperature, but also in proportion to the amount of organic matter present, so long as this is not in any great excess. The correlation between number of bacteria and percentage of humus is one that necessarily suggests itself, just as it is natural to assume that the most fertile soil is, *cæteris paribus*, that one containing the optimum amount of this constituent. The addition therefore of organic manures to any soil will affect the numbers and activities of the soil organisms in proportion to the resulting approximation to the optimum humus content; that is to say, that we may expect to find not only an increase in the number of bacteria but a proportionate rise in the degree of biologic activity on addition of organic matter such as oil cake or green manure to a soil which previously contained less than the optimum amount. In the

present state of our knowledge of the subject we are not able to make any very accurate use of this method of determining the reaction of a soil to such treatment, but further study of the complex factors involved will no doubt increase our knowledge of the relation between humus content and fertility. Such study must include observations not only of the numbers of bacteria associated with varying contents of humus, but of the effects of such variation upon the relative numbers of the different kinds of micro-organisms, and upon the total resulting changes in the condition of the plant food which depend upon their activity. The effect of the addition of vegetable matter to a soil may be considered under three heads: (1) as directly adding nitrogen in the form of nitrogenous plant tissue; (2) as stimulating the action of nitrifiers; (3) as encouraging the growth of nitrogen fixing organisms such as Azotobacter, which, if supplied with carbohydrates, such as sugars, can take up free atmospheric nitrogen which is thus added to the store of this element in the soil.

Under the first two heads come green manures, roots and stubble and weeds either growing with the crop or ploughed in after fallowing; under the third head we find comparatively few instances in actual practice and the result of their application is only doubtfully to be assigned to the fixation of atmospheric nitrogen. The use of molasses in Mauritius on sugar-cane soil may no doubt depend for its efficacy upon such action, and it appears probable that certain artificial cultures ostensibly purporting to convey root nodule organisms into the soil mainly affect the nitrogen content of the latter through the agency of nitrogen fixers such as Clostridium, which do not enter into symbiotic relationship with leguminous plants. I do not propose to deal with this aspect of soil fertility, and shall therefore omit any special reference to the reaction of soils to treatment calculated to encourage the growth and activity of Azotobacter or similar nitrogen fixers.

The problems involved in the management of the operation of green manuring will naturally resolve themselves into a series of investigations as to the effect of this process upon the biologic

condition of the soil. The point of growth at which the green crop may be ploughed in with the best results, and whether this should be done directly, or after cutting and drying; the effect of adding lime or gypsum to the soil at the time of ploughing in and of the distribution of the rainfall, all these points are evidently so closely connected with the biological factor as to demand exhaustive biological analysis, which alone can give any satisfactory indication of the best method of dealing with such questions.

Similarly in the case of cattle manure, the information provided by chemical analysis as to the amount of plant food introduced into the soil in this form will give but meagre indications of its real relation to fertility. It is necessary to take into account not only the amount of plant food in the manure and the specific effect of the latter upon tilth, but also the capacity of the soil to deal with it successfully through the agency of bacteria, which depends not only upon the presence of the latter in sufficient numbers but also upon a proper supply of water and air, secured only by the amenability of the soil itself to tillage. Furthermore, it is of no less importance to consider the effect of the cattle manure as a conveyor of bacteria into the soil, but the complexity of this aspect of its functions as a fertilizer makes it inadvisable to deal further with it at present.

The relationship between bacterial activity and manuring with artificials, such as superphosphate, potash and lime, has not so far been studied very closely, except in the case of nitrification. Here a very intimate relationship has been shewn to exist between the amount of nitrification effected and the presence of lime; and the same has been found to a lesser degree to be the case with phosphates and potash. The action of sulphate of ammonia upon the soil in producing an acid condition of the latter must be taken into account as influencing its bacterial activity, and the effect produced by certain potash manures upon the texture of the soil has similar results. Fallowing and the rotation of crops must also of necessity affect the constitution of the soil complex and depend largely for their effect upon this action.

It will be seen, therefore, that the success of every agricultural operation, designed to increase the fertility of the soil depends very largely upon its effect upon the activities of soil bacteria, although these methods of treatment have been arrived at empirically and without any knowledge of this relationship. The evolution of many other arts requiring the intervention of micro-organisms has depended upon similar empirical methods, such as those which were in use in distilling, brewing, dairying and vinegar making, until comparatively recent times. The great improvements effected in such industries by scientific study of the organisms involved, gives us good reason to expect that the science of soil bacteriology, at present in its infancy, will in its turn do for agriculture what similar methods of research have done for these other arts.

Laboratory Methods.

The following description of the methods in use in the laboratory to determine the reaction of soils to the various agricultural operations described above, is not intended as a guide for laboratory use, but merely to give an indication of their scope, and may perhaps afford some further insight into the possibilities and limitations of soil bacteriology. It will be seen from this description that our knowledge of the changes produced by bacterial action depends upon (1) observation of the actual growth of bacteria, and cultural methods adopted for their separation, identification, and enumeration, and (2) chemical analysis designed to ascertain the results of bacterial activity in artificial culture media and in soil samples.

Culture media are designed to promote the growth of micro-organisms and are either intended to allow of the development of all organisms, present in the soil sample within wide limits, or have a special constitution which will favour the growth of certain bacteria whilst preventing that of others which may be present. Media may be either solid or liquid, the former class including such media as gelatine and agar and the latter such solutions as beef broth, peptone solution, and special

solutions containing the elements essential for growth, but characterized by the presence of certain inorganic salts or organic compounds, which serve either to promote the growth of certain bacteria if present, or to indicate their power to produce certain special chemical changes. As an example of the former may be instanced the special solution containing mannitol or mannite which promotes the growth and nitrogen fixing activity of Azotobacter, and of the latter class an example is afforded by nutrient solutions containing, in addition to the necessary elements, sulphate of ammonia, the oxidation of which to nitric acid may be measured, and the amount of the latter formed taken as an indication of the presence and activity in the soil sample of nitrifying organisms. The solid media gelatine and agar owe much of their usefulness to the fact that they may be liquefied by heat, and in this condition inoculated with the soil extract containing the bacteria whose characters it is desired to determine. In the description of the operation of plating which follows, the value of this property will be shewn and indeed it may be said that bacteriology has made its greatest advances as a science as a direct consequence of the introduction of this method by Koch. It would be impossible within the limits of this paper to give any further account of the numerous media which are employed in soil analysis; but it is hoped that the description of the special methods which follows will give some idea of the bearing of their composition upon their utility in determining the presence and general character of soil bacteria.

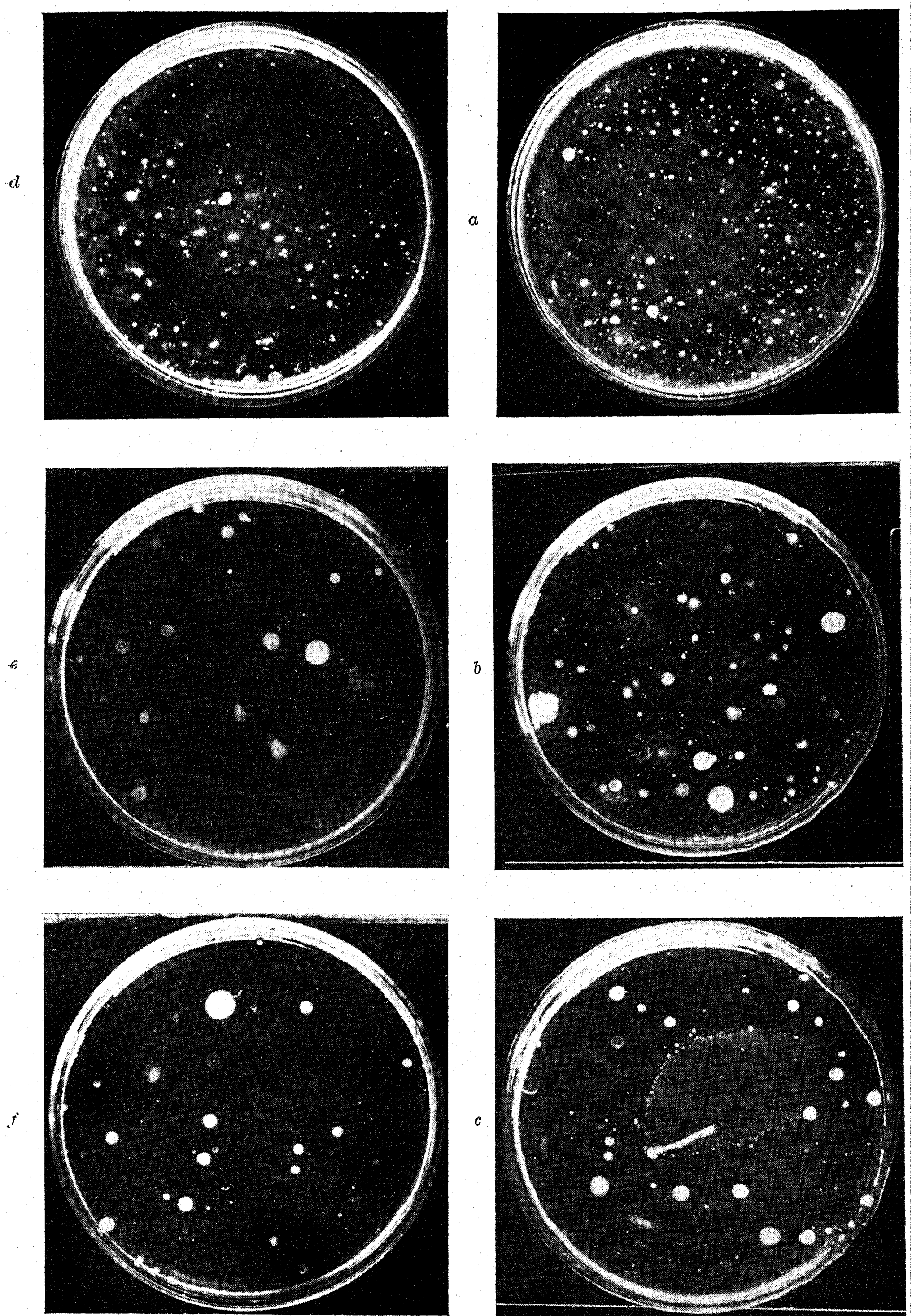
Plating.

A weighed quantity of the soil to be examined is shaken up with sterile water and a small portion of the extract thus obtained introduced into a test tube containing the medium, either gelatine or agar, the latter having been previously liquefied by heat, and kept at a temperature sufficiently high to ensure fluidity but not high enough to kill the bacteria. The liquid medium is then stirred to distribute the bacteria evenly throughout it, and is poured out into a flat glass dish with a loose cover (a Petri

dish) and allowed to set by cooling, after which it is kept in an incubator at a constant temperature. After 12, 18, or 24 hours, bacterial growths will be found forming "colonies" upon or under the surface of the medium. The dilution with water referred to above is made use of in order to reduce the number of bacteria present to an amount which will allow of the separation of the individual bacteria from one another by sufficient distances to prevent over-crowding of the plate with colonies; each colony is produced by reproduction from a single bacterium, and it is this fact, together with the solidity of the medium, which prevents the bacteria contained in it from moving about, which makes it possible to obtain pure cultures, that is, cultures containing only one kind of bacterium, by this method, if the dilution is sufficient to separate the individual colonies from one another.

Plate XIX reproduces photographs of soil plates prepared in this manner, shewing the varying numbers of colonies obtained from poor and rich soils, and from different depths in the same soil. It is from such plates that counts are made of the numbers of bacteria actually present in the same weights of various soils, and indications obtained of the variation produced by different methods of treatment, such as partial sterilization by heat or antiseptics. In Plates XX and XXI are shewn the action of hot air, steam, drying at 50° C. and various antiseptics, in reducing the normal number of colonies. Such plates are of use in determining the value of various methods of sterilizing soil samples, this last being a necessary preliminary to many laboratory methods of investigation, but are reproduced here mainly on account of their interest in connection with recent theories of soil fertilization by partial sterilization. I do not propose to consider these theories at present, but I have introduced the plates in question as of general interest in connection with the subject of plating, and of particular interest as illustrating the effect of hot weather ploughing or "weathering" upon the bacterial content of Pusa soil.

Although it is impossible in a photograph to do much more than shew numerical variation, it will be easily understood that



A. J. I. Poor Soil. Rich Soil.

Dilution 1 in 100,000.

examination of the plates themselves reveals differences of a much more complex order. Thus, after heating a soil for three days to a temperature of 60° C., although no great difference in number of colonies may result, yet a very obvious alteration in their character is generally apparent. It must be understood that the kind of growth, or "cultural character," which is formed by a bacterium is a more certain means of recognizing its species than is its form as seen under the microscope ; bacteria which appear similar so far as their form is concerned, presenting easily recognized differences when grown on various media.

These "cultural characters" include variation in the form and colour of the "colonies," and differences of behaviour towards the medium, such as are presented by liquefaction of gelatine media or the production of acid and gas in those containing sugar. On these lines a complete analytical scheme is made use of, resembling those adopted in chemical practice, in which the various culture media take the place of chemical reagents, being utilized to distinguish between species of bacteria by the differences in the reaction of the latter to the media on which they are cultivated.

Having obtained information by plating as to the numbers and species of bacteria present in the soil under examination, further investigation is aimed at determining its capacity for producing plant food from organic matter by ammonification and nitrification. As an introduction to the description of the analytical methods employed to determine the extent to which these two processes can be carried in any particular soil, it is necessary to draw attention to the distinction which must be made between the power of a soil to produce nitrification, depending upon the numbers and activity of nitrifying organisms it contains, and its capacity for nitrifying organic matters introduced into it, which depends indeed upon the activity of the bacteria, but still more so upon the physical condition of the soil itself with regard to water-supply and aëration. It is for this reason that special methods of ascertaining the nitrifying capacity of a soil are made use of, involving recognition of this fact, and intended to deter-

mine not only the nitrifying capacity of the soil, but under what conditions of water content, aëration, humus content or supply of such substances as lime, phosphates or potash, the most favourable results may be obtained. This has been referred to above as a method of determining in the laboratory the reaction of a soil to treatment in the field : and it is hoped that a description of the method will provide some indication of the value of soil bacteriology as an aid to elucidating the primal problem of fertility and its causes.

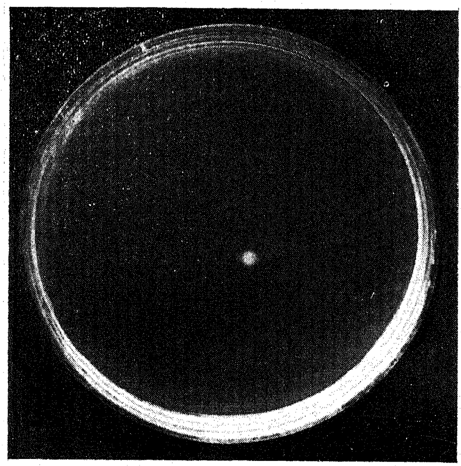
NITRIFICATION.

This process is so intimately connected with the provision of available nitrogenous plant food, that the nitrifying power of a soil may be considered as a limiting factor in fertility. The primary object of the laboratory examination of soil samples is not, however, the mere measurement of their relative nitrifying powers alone, but is intended to discover (1) what nitrifying power they possess, and (2) under what conditions this may be made the most of. Remembering that "nitrification" means generally the conversion by bacteria of organic nitrogen, which, in the form in which it exists in vegetable matter is not available as plant food, into nitrates, which are readily assimilable by crops, our aim is to discover the capacity of a soil to produce this effect upon addition to it of organic matter such as green manures, cattle manure or oil-cake. A special case is the oxidation of sulphate of ammonia when used as a manure and this reaction may also be measured in the laboratory.

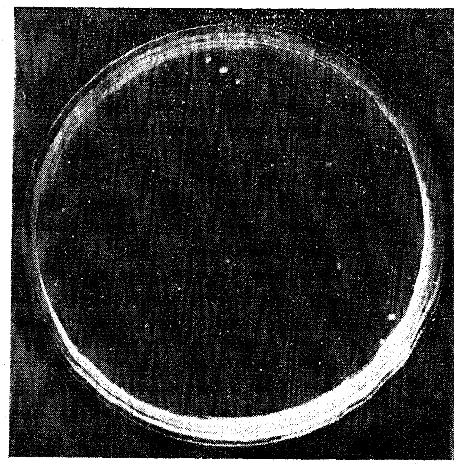
Two alternative methods can be adopted for estimating the nitrifying power of a soil ; a weighed quantity of the soil sample may be introduced into a liquid medium containing sulphate of ammonia in addition to the necessary nutrient salts, or a measured volume of a watery extract of the soil may be poured over a sterilized portion of the same soil, to which a known quantity of nitrogenous matter has been added. In either case periodical analyses are made, of the solution in the first method, and of the soil medium in the second, to determine the amounts of nitrite and

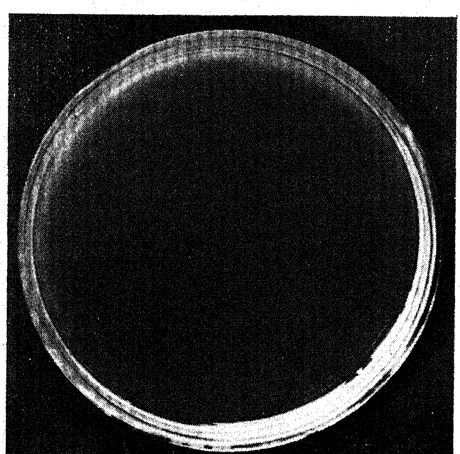
PLATE XX.

HOT AIR.
150°C. ½ HOUR.



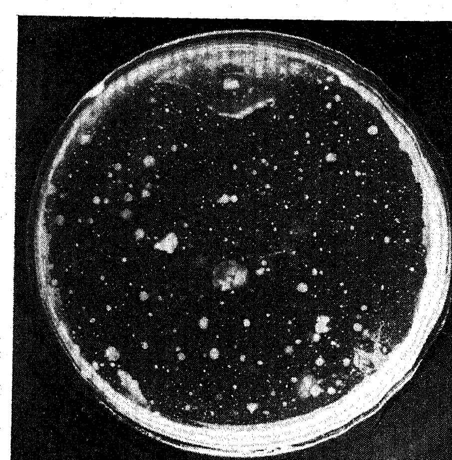
STEAM STERILIZER.
1 HOUR 100°C.





A. J. I.

AUTOCLAVE. 2 DAYS.
130°C. ½ HOUR.



EXPOSED TO SUN.
50°C. 6 DAYS.

nitrate which have been formed. It has been found that the first method, originally proposed by Oméliansky and others, does not give certain indications of the nitrifying power of a soil owing to the lack of aëration in the liquid medium, and the want of approximation to those natural conditions which obtain in the soil itself. The laboratory measurement of nitrification at Pusa is therefore made by the second method, although this involves the use of larger soil samples and is generally more laborious.

By this method it is possible to measure approximately the amount of nitrate produced in various soils from organic matter added in the form of (1) green manure, (2) oil-cake, (3) cattle manure, (4) crop residues such as straw, stubble, roots, etc., (5) sulphate of ammonia used as artificial manure. Further valuable indications may be obtained as to the effect upon nitrification of various agricultural operations; thus the optimum amount of water for nitrification in the particular soil under examination may be determined by varying the amount added to the soil medium; the effect of cultivation with consequent aëration may be observed by periodical stirring of the soil medium, and also the result of adding lime and artificials such as potash and superphosphate. In many cases in actual practice the fertility of a soil has been found to be prejudicially affected by the use of certain manures and in other instances their addition has not resulted in the expected increase of crop. Determination of the effect upon the nitrifying power of the soil of such manures may shew that their failure is due to their relation to this factor in fertility, and may indicate a variation in treatment in the field accordingly. Thus the successful use of sulphate of potash for a crop requiring potash to produce a full return might depend upon its application at such a time of year as would not interfere with the activity of the nitrifying organisms and the consequent supply of nitrates for the crop, or again, more complete information as to the nitrifying processes in a soil obtained by laboratory examination might indicate the advisability of ploughing in a green manure at a particular stage of its growth coincident with a certain water content of the soil or with a condition of the

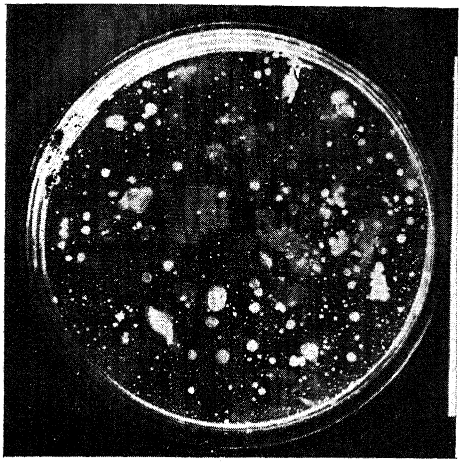
plant itself favourable to attack by those micro-organisms responsible for the initial stages of its decay.

AMMONIFICATION.

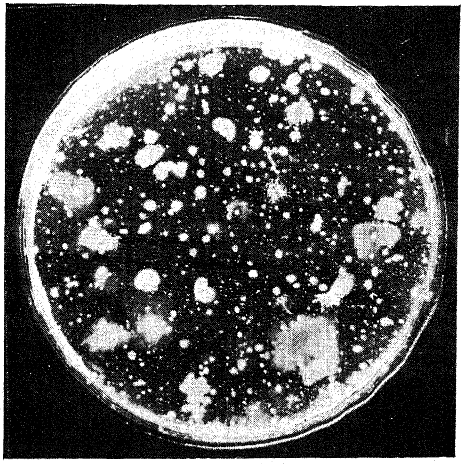
Before nitrification can take place in a soil the nitrogen contained in its humus must be converted into ammonium salts; this change depends upon the presence and activity of micro-organisms either bacteria or fungi, many species of which may be classed as ammonifiers in consequence of their power to produce ammonia from nitrogenous organic matter. The ability of a soil to deal successfully with organic matter will therefore depend upon the presence therein of ammonifiers and the general suitability of the soil itself as a medium for their growth and activity. Observations may be made in the laboratory on simialr lines to those described above in connection with nitrification, to determine the ammonifying power of a soil sample. For this purpose a weighed quantity of the soil is introduced into a solution containing peptone, a soluble form of nitrogenous organic matter, periodic determinations of the ammonia formed being made. Further and more useful information as to the ammonifying capacity of a soil may be obtained by the use of the soil itself as a medium, as described above in the case of nitrification, and in actual practice parallel determinations of the ammonia and nitrates produced are carried out in duplicate samples. If it is wished to determine the suitability of the soil under examination for the growth and activity of ammonifying organisms, a sterilized sample may be inoculated with a pure culture of such a bacterium as Bacillus Mycoides, after admixture with a measured quantity of some such organic nitrogenous substance as oil-cake, the rate of production of ammonia affording an indication of the condition of the soil with regard to bacterial growth and action. In this case again, information as to the reaction of the soil to treatment in the field may be obtained by modification of the water content, addition of organic or mineral manures or of lime salts, and further problems as to the effect of water-logging, of compacting the soil, and of ploughing in the

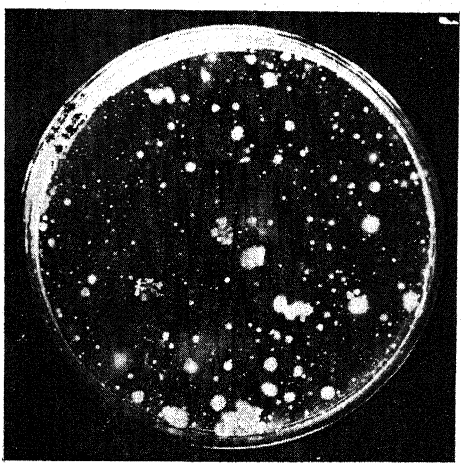
PLATE XXI.

TOLUENE 5%.
3 DAYS.

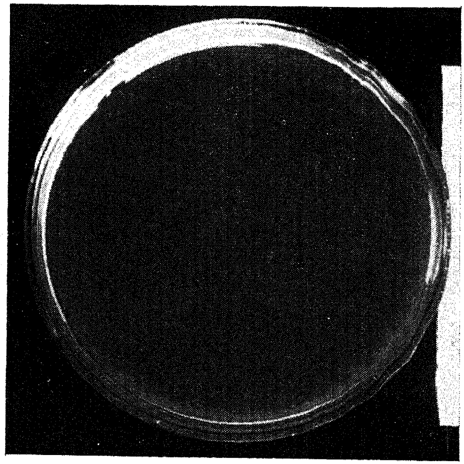


CONTROL. UNTREATED.





A. J. I. THYMOL SATURATED.
5% SOLUTION.



FORMALDEHYDE VAPOUR.
24 HOURS.

hot weather or in the rains, may be studied from the biological point of view.

Recent work on soil bacteriology at Rothamsted has demonstrated the intimate connection between the presence of ammonifiers and fertility; it has been shewn that plants can assimilate nitrogen in the form of ammonia without its conversion into nitrates, and it has further been proved that the increase in fertility produced by partial sterilization of a soil is directly connected with the corresponding increase in the number of ammonifiers. Partial sterilization may be effected by a moderate degree of heat—98°C., or by the use of antiseptics such as toluene; the immediate result of such treatment is the destruction of all actively growing (vegetative) micro-organisms, and plating shews a corresponding diminution in the number of colonies, but further plates made after an interval of some days shew by their numerous colonies that some forms of life have survived the sterilizing treatment and have subsequently multiplied in the soil. This survival is limited to those forms which can produce spores as a method of reproduction, these spores being particularly resistant to the action of heat and antiseptics, enabling the organism to withstand high temperatures, as in the case of Bacillus Subtilis, the so-called Hay Bacillus, the spores of which survive boiling in water for as much as an hour without losing their vitality. It has long been known that partial sterilization produces increased fertility, but this has been generally considered to be due to alteration in the chemical content or physical texture of the soil. The Rothamsted experiments give good reason to suppose that such increase is mainly due to the destruction by the heat or antiseptics of all living soil organisms except those existing as spores, thus removing from the soil those protozoa (ciliata and amœbæ) which prey upon and keep down the ammonifying bacteria. Upon the removal of the antiseptic, or return of the soil to its normal temperature, the surviving spores germinate, and the bacteria, unchecked by the predatory protozoa, multiply rapidly, giving rise to a corresponding increase in ammonia production and consequent supplies of available nitrogenous

plant food. This view has a special interest in India, as it appears to indicate a possible cause for the increased fertility produced by hot weather ploughing. Mr. Howard of Pusa, who uses the term "weathering" for this operation, is of opinion that partial sterilization is effected by the high temperature, about 60°C. to which the surface soil is raised under the hot sun of April, May and June. I have found that this temperature actually produces an alteration in the bacterial content of the soil, and if it penetrated to the lower layers it would no doubt eliminate many of those bacteria which produce unfavourable soil conditions such as result from the elaboration of organic acids, such as butyric acid from humus. The actual results of "weathering," so far as I have been able to ascertain them in the laboratory, are as follows :—

First.—More or less complete desiccation of the soil resulting in the death of most protozoa and many bacteria.

Second.—Complete aëration, producing conditions highly favourable to nitrification and preventing acid fermentation of humus.

The alteration of the physical texture of the soil and all the effects associated with proper tilth do not come within the scope of this paper, but it will be readily realized that they must play an important part in the preparation of the soil for cultivation of crops. Mr. Howard has described elsewhere the increased fertility due to this method and has emphasized the obvious increase of available nitrogenous food to be inferred from the general appearance of the crops raised on "weathered" soil. Further investigation is being carried out of the causes underlying this result, and it is hoped that some useful information may be obtained by bacteriological analysis.

Certain bacteria develop more rapidly under conditions which prevent free access of oxygen; these are known collectively as anaërobes and include many of those bacteria which are responsible for detrimental reactions in the soil such as denitrification and acid fermentation. Denitrification implies

the reversal of the beneficial process of nitrification, the result being the reduction of nitrates to nitrogen gas, which then escapes as such into the air and is lost to the agriculturist Fortunately it is possible to avoid much of this loss by methods of cultivation which ensure proper aëration of the soil ; tillage and draining effect this purpose by increasing the supply of air and limiting that of water. In the laboratory it is possible by artificially reducing the supply of air to a soil plate to measure the resulting increase of the anaërobes present ; this may be done by enclosing the cultures in an airtight vessel from which the air or oxygen is then removed, or more simply by covering the surface of the medium with a glass plate. The results of many agricultural operations are modified by the intervention of anaërobes, especially in the case of the conservation of cattle manure, the ploughing in of green manures in wet soil, and wet rice cultivation, and laboratory investigations will, it is hoped, help to elucidate some of the problems connected with these operations in India.

In addition to the loss of nitrogen produced by denitrification, further harmful effects are liable to follow from the prevalence of those conditions which give rise to it. A large number of soil bacteria are capable of acting upon organic matter in such a way as to produce organic acids, notably butyric acid, under such soil conditions as result from inefficient methods of cultivation with imperfect aëration and drainage. This is especially the case when large amounts of organic matter are introduced into the soil as green manures, without being followed by proper tillage and preceded by efficient drainage. Laboratory examination of soil in this condition reveals the cause by discovering the presence of an undue number of such bacteria as are associated with acid fermentation of organic matter. The acidity of the soil resulting from such conditions is most unfavourable for the proper operation of the beneficial micro-organisms described above, and in general terms may be said to reduce the biologic activity of the soil and therewith its fertility.

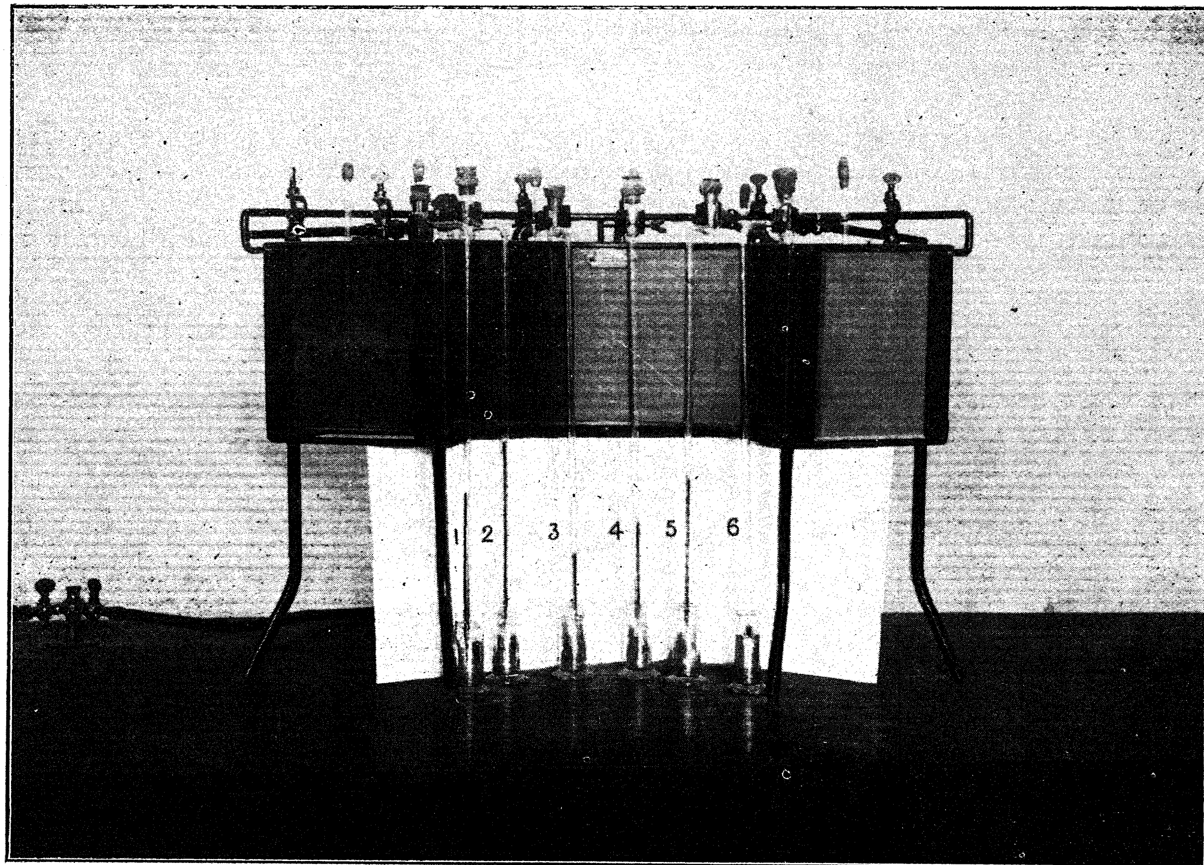
The life processes of bacteria result in the production of carbon dioxide gas, and in general terms it may be said that the

amount of this gas formed in a sample of soil, containing no living higher plants, may be taken as a measure of the biologic activity of that sample. Dr. Russell of Rothamsted has devised a form of apparatus for estimating directly the amount of carbon dioxide formed in a measured quantity of soil, and this apparatus may usefully be employed for determining, not so much the relative biologic activities of various soils, as the effects upon the bacterial life contained in them, of such methods of treatment as we have been considering with reference to field practice. The photograph of this apparatus shows its general arrangement; the soil sample is introduced into a glass flask communicating with a side bulb containing caustic potash, and having a calibrated tube dipping into mercury, the whole being hermetically closed. In the photograph Plate XXII it will be seen that there are six of these flasks contained in a water bath to ensure even temperature, with calibrated tubes dipping vertically into mercury reservoirs. The carbon dioxide formed by the soil bacteria is absorbed by the caustic potash, thus lowering the gas pressure in the flask and causing a corresponding rise of mercury in the vertical tube; this rise is measured periodically and may be taken as indicating the relative amounts of bacterial action going on in the samples. Unfortunately, the results are liable to be interfered with by the evolution of other gases than carbon dioxide such as nitrogen and marsh gas, which may set up an increase of pressure and thus nullify the readings, and although this is not likely to happen in the majority of cases, the possibility of its occurrence limits the use of this apparatus in laboratory practice. Nevertheless it is of value in certain cases where it is desired to ascertain the effect of varying methods of treatment on the same soil, such as variation in percentage of water, or the addition of organic matter, or of artificial manures.

Pot Cultures.

The general result of the individual activities of the bacteria which I have dealt with above, in modifying the fertility of the soil, can be only roughly estimated from theoretical consider-

PLATE XXII.



A. J. I.

Dr. Russell's Apparatus.

ations; a nearer approximation can be arrived at by testing the fertilizing action of various bacteria by means of pot cultures. Owing to limitations of space I do not propose to describe this method, but will merely say that just as it is possible to make up artificial soils containing varying quantities of plant foods, so can various bacteria be added to a previously sterilized soil, and their action upon its fertility be noted. The principal difficulty lies in the initial stages of the work; to completely sterilize a soil without producing deleterious substances from the organic matter it contains is a matter of difficulty, and to avoid the accidental introduction of bacteria or fungal spores in the process of sowing seed in the pots requires very special precautions which may fail to ensure success, without affording any indication of their insufficiency at the time. I hope in a future issue of the Journal to give an account of the methods in use at Pusa to test the action of bacteria on soil fertility by pot cultures.

RURAL ECONOMY IN THE BOMBAY-DECCAN.* II.

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Director of Agriculture, Bombay.

(*Continued from page* 318 *of Part IV, Vol. V.*)

IV.—Capital.

Before dealing with the many particular forms in which Capital is essential to the farmer, it will be as well to start with a few facts regarding the nature of capital in general.

Capital is wealth set aside to assist in future production. It can be employed in production not only by the owner, but by another who may borrow it for the advantages that he can obtain from it. The interest which he pays for it represents the price of the advantages which he hopes to obtain. This price, like the prices of other commodities, is mainly regulated by demand and supply, if we exclude the question of risk. Thus we find that in Europe the general tendency of the last thousand years has been for the rate of interest to fall, denoting a steadily increasing supply of capital. For loans on good security the rates of interest in Western countries have roughly fallen as follows :—

1400 A. D.	10%
1500 A. D.	8%
1600 A. D	6½%
1700 A. D.	5%
Present day	4%

In England at the present day a landowner can raise a mortgage on his land at about 4 per cent.

* For purposes of statistics the term Deccan has been taken to refer to the Central Division of the Bombay Presidency.

Space will not permit here to go into the history of loans to farmers in the Deccan and the interest paid by them in the past; but it may be stated that at present a public body like the Bombay Municipality with first class security can borrow at 4 per cent.; a holder of good land situated in a favourable part of the Deccan who has a reputation for honesty could raise a moderate mortgage on his land at about 9 per cent.; while for a short accommodation on good security (*e.g.*, a standing sugar-cane crop), a man would have to pay about 15 per cent., a rate which has been fairly uniform during the past century. This high rate of interest in the case of good security is due to several causes. Capital is very scarce in the Deccan, and for want of organisation the cultivator cannot get in touch with the money market of the towns, and is often unable to realise what credit he has got. Further a creditor who finds it necessary to foreclose on a mortgage may discover that he has to face not only the worry of a civil suit but also a hostile combination of the cultivators in the village where the land is situated. In cases where the security is land but is less good than in the case mentioned above, a cultivator may pay anything up to 24 per cent. interest for a loan. Loans on personal security are made by particular classes of money-lenders and any rate of interest up to 100 per cent. may be charged. These rates of interest will appear to many to be very high; but it is necessary to look at the facts from the point of view of the lender as well as that of the borrower; and when consideration is paid to the risks of losing the capital, to the trouble involved in collecting the interest and to the personal enmity which the village money-lender often incurs, it may be doubted whether they are excessive. A century ago in parts of the Deccan, the village *bania* was afraid to stop in his own house, but would sleep in a different house every night, so as to elude anyone who might have designs to offer him violence. Even since the advent of more settled conditions the money-lenders of the Deccan have at various times been the object of open attack by the landholders whose lands they had acquired; and in the present day cases are not uncommon where both the person and the property of the

village money-lender are the subjects of violence on the part of the villagers.

Economists may truly point out that the man who provides capital is a public benefactor since, by the use of capital, production is cheapened and the community gains; but the prejudice against money-lending, which led to the strict rules against the taking of interest, framed by the early Christian and Mohamedan churches, is still shared by many. In the relations between money-lenders and cultivators there is much give and take; but in the long run the tendency is for the debtor to do most of the giving and the creditor the taking. Many instances can no doubt be cited against money-lenders of unfair bargains, harsh treatment and fraudulent accounts; but the fact remains that the small village money-lender does not usually acquire much wealth, though he often lives a more laborious and frugal life than many of his clients. If the risks, labour and, in many cases, the unpopularity of his calling be taken into consideration, it is doubtful whether the interest which he charges is higher than the conditions warrant.

To turn to the farmer's capital, its various uses may be tabulated as shown on page 117.

Many farmers would probably consider the above classification to be unnecessarily comprehensive, and to include forms of capital to which they pay little or no attention. If a man's business is to be put on a sound basis, however, and the maximum profit extracted from the land every form of capital enumerated above must be provided for in some way or other; and it is only by a proper understanding of each form of capital that correct accounts can be kept and the true source of profits and losses determined. With regard to the land and the labour supply, a farmer can often do little to alter the conditions in which he finds himself, and can only adapt himself to them as best he can. In the management of his capital, however, he has more scope for the exercise of discretion; and it is to a great extent on his business management that his financial success will depend.

CAPITAL.

- Fixed capital.
  - Land.
  - Permanent additions and improvements to the land, *e.g.*, buildings, wells and embankments.
- Working capital.
  - Stock.
    - Live stock.
    - Dead stock.
  - Circulating capital, *e.g.*, manure, produce on hand, ready money for paying wages.
  - Reserve fund, *e.g.*, sinking fund, insurance, repairs.

To consider the various forms of capital in order—

Land has been already treated separately. When the farmer owns the land which he cultivates, it, of course, forms part of his capital. In the Deccan it unfortunately forms in many cases almost the whole of the cultivator's capital. Land should offer good security for borrowing at moderate interest the capital necessary to work it; and about half the land is mortgaged to a greater or less extent; but as has been already shown, the cultivator is often unable to realise his credit, and fails to obtain capital except at very high rates of interest. Even this would not matter so much if the money borrowed were all devoted to productive purposes, or if a reasonable sinking fund were established by the borrower to enable him to pay off the loan. But this is seldom the case; and the burden tends to become cumulative. It is unnecessary to say more about land as a form of capital except to observe that the more land a man has, the more of other forms of capital also he should possess, and that the farmer whose whole capital is sunk in land and permanent improvements is at a disadvantage as compared with a man owning less fixed and more working capital.

V.—Permanent Improvements.

Few people probably, who are familiar with the landscape of rural England, realise what changes in the scene have been effected by the expenditure of labour and capital in the past. To note the difference it is not necessary to go back to remote ages when the valleys in many parts were covered with forest and swamp, and cultivation was confined to the higher ground. Progress has no doubt been continuous for centuries past; but it is the expenditure during the last two centuries on enclosures, field drainage, pastures, wind breaks and farm buildings, that has enabled the English farmer to survive the depression caused by the ruinous fall in the prices of agricultural produce, due to the foreign competition resulting from improved communications. The outcome has not been particularly profitable to the landlords who incurred the expenditure; since in many

localities the value of land is now no greater than the cost of the buildings and other permanent improvements attached to it; and the owner has often been compelled to sell his land for anything that it would fetch to some one with an income derived from sources other than agricultural, who could afford to keep in repair the improvements that his predecessor had effected. But the matter is more than a question of money; and the landowners of England have this to their credit that they have borne the burden which every other country in Europe shifted on to the shoulders of the whole community by means of protective duties; and so have justified the policy of the 17th century which put so much of the common land in England into their hands.

To appreciate the significance of the improvements that have been effected the inquirer need not go further than the west of Ireland to see what unimproved land means; a desolate stretch of wind-swept bog-land without a fence or a tree; with no signs of life but a few stray huts, each with its potato patch and guarded by a small boy to drive off stray animals. With capital laid out in reclamation this land might support the ship-loads of emigrants who yearly make their way to America, and more besides. In default of such capital the tract becomes a "Congested District" by virtue of the scanty population which it retains. Conditions in India are very different to those in England, and there has not been much disposition on the part of the proprietors in the Deccan to improve and develop the resources of the land. In the western portion some careful and laborious terracing has been done on the hill sides by the smaller owners. Here and there a favoured tract will be well supplied with irrigation wells, and some farm buildings may be seen in the fields; but over the greater portion the landscape owes nothing to the hand of man, and the fields lie unwatered, unfenced and unembanked, without shelter for man or beast. In a dry country like the Deccan, the prime agricultural necessity is water, and in many localities where rainfall is scanty the annual produce of the land can be increased ten-fold by perennial

irrigation. The larger irrigation works have been constructed by Government; and in the Central Division alone 110,000 acres are annually watered from Government canals. These irrigation works have in the past 40 years involved a capital expenditure of Rs. 260 lakhs. Work is in progress on additional irrigation schemes estimated to cost Rs. 211 lakhs; plans and estimates have been prepared for a large scheme costing over Rs. 300 lakhs and calculated to irrigate about 3 lakhs of acres in the driest part of the Deccan: while a preliminary survey has been made for irrigation works calculated to water $2\frac{1}{2}$ million acres in the Deccan and Southern Maratha country. Private enterprise is responsible for some 150,000 wells irrigating about 348,000 acres; for small tanks irrigating about 4,000 acres; and for the construction of dams and channels from streams which water 65,000 acres. These latter are led from a permanent or temporary dam, often with much ingenuity, along the contours of the bank till they can command a cultivated field.

From the above figures it will be seen that irrigation has not been entirely neglected. The fact remains, however, that out of 13,056,000 acres cultivated in the Central Division only 527,000 acres can at present be irrigated; that is to say, only 4 per cent. of the whole. The possibilities of large reservoirs are limited, and, such as they are, they are being realized by degrees. Few small streams which run for any length of time after the end of the rains are neglected by the cultivators; but there is a large field for profitable investment of capital in digging wells in localities where the subsoil water is reasonably near the surface. Another source of irrigation which is neglected consists in the perennial supply contained in many reaches of the larger rivers. The great difference in the water levels of the wet and dry seasons presents an obstacle to the convenient utilisation of such water, and conditions are seldom favourable for lifting it in the traditional way with the *mōt*, or leather water-bag; but by the use of engines and pumps this difficulty can be overcome. Experiments are now being made with various kinds of engines and pumps to ascertain the cost of lifting water in

this way; and there can be little doubt that under suitable conditions capital can be most profitably utilised in this way. A note of warning must however be sounded in connection with investments of this description. It is no use for a man to sink capital on such improvements unless he has sufficient working capital to run the plant. The same argument applies in a less degree to the construction of wells; for it is not an uncommon thing to find a cultivator who has exhausted his capital, and possibly his credit, in digging a well, and then finds that he has no means to work it properly or keep it in repair. A useful form of small investment consists in the construction of field embankments, known as *tâls,* which prevent erosion and scour during heavy rain, and retain in the soil the rain water that falls. When combined with field levelling and tree planting, and skilfully executed, they are of much value. Such works may be large or small, and there is hardly a cultivator who could not make some small improvement of this nature every year at little or no cost beyond his own labour.

It has already been remarked that the cultivator very seldom lives in his holding. The farm buildings form part of the cultivator's house in the village and are for the most part of a very primitive kind. It is not to be expected that a man will lavish conveniences on his cattle which he does not obtain for himself; but it is certain that the absence of comfort and sanitation that characterises most cattle sheds must have a prejudicial effect on the stock. The surplus produce of the fields is seldom sufficient to demand elaborate store houses, but such as it is it often suffers considerably, the grain from weevils and other insects, the fodder from lack of protection against the rain; and for want of suitable buildings the cultivator often loses much of the profits of his labour.

In view of the high standard of cultivation in many parts the most remarkable feature is perhaps the complete absence of any permanent fences. A live fence cannot be produced at once, but in the course of a few years it can be produced at no cost beyond the labour of part of the cultivator's spare time.

The advantages to be derived from fences are not immediate or perhaps very obvious; which presumably accounts for the fact that none are made; but it cannot be doubted that very real and substantial advantages would be derived from their existence. Looking at the matter as it affects the crops, it is common to see growing crops seriously damaged by the inroads of stray animals; and in outlying fields the difficulty of guarding rabi or garden crops against such damage often deters the landholder from cultivating them at all. The cattle too, on their side, often suffer seriously from feeding on young crops; and roaming as they do over the unsheltered grazing grounds, the healthy with the diseased, live under circumstances which are anything but conducive to health and condition. Much of the labour now spent on herding cattle and guarding crops might be saved by the existence of well-kept fences, which would do the work far more effectively, and entail but little outlay either for construction or maintenance.

Writers are accustomed to contrast the output per acre of one country with that of another. Before such a comparison can be effective, consideration must be given to the capital which has been sunk in permanent improvements. In England such improvements have been roughly estimated as representing an average value of £12 (Rs. 180) per acre. Allowing 8 per cent. for interest, depreciation, repairs and insurance, it will be seen that the net annual charge against each acre of land on account of permanent improvements will be about £1 (Rs. 15). As regards the Deccan if we take Rs. 400 as representing the average cost of a well (taking masonry and non-masonry wells together), the

capital sunk on wells amounts to ...	Rs.	60,000,000
Add capital cost of Government irrigation works	„	26,000,000
Add capital cost of private irrigation channels from streams and small dams (rough estimate)	„	4,000,000
Total ...	„	90,000,000

The capital cost of irrigation works thus comes to about Rs. 900 lakhs. Dividing this by 5 lakhs of acres irrigated we find that for irrigated land the capital sunk in permanent improvements works out to about Rs. 180 (£12) per acre, or the same sum per acre as is estimated to be sunk in permanent improvements in England. The above calculation is of necessity a very rough one, and takes no consideration of outlay in levelling land, which is frequently necessary where irrigation facilities exist. It will suffice however to show that in comparing English with Deccan outturns per acre, it is the irrigated land which, from the financial point of view, offers the best basis for comparison ; while as regards the unirrigated land which forms 96 per cent. of the whole cultivated area, it must be remembered that in the matter of permanent improvements there is little for which the present has to thank the past; for the amount of capital per acre sunk on permanent improvements is almost negligible. If the gross outturn per acre obtained on the dry lands of the Deccan compares badly with that obtained in England, this fact must not be overlooked.

THE PROGRESS OF AGRICULTURE IN JAPAN.*

REVIEWED BY A. McKERRAL, M.A., B.SC.,

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In a preface to this little book of 130 pages by the Director of the Agricultural Bureau, the object of the book is stated as being "for the purpose of acquainting foreigners with the general outlines of agriculture in Japan," and as the book has been written by a Japanese, an apology is offered for the English in which it is couched. There are certain passages which, as the preface says, 'lack intelligibility" more or less, and it certainly is regrettable that the book was not placed for revision in the hands of a competent English scholar, but on the whole the expression is probably clearer than one might have expected under the circumstances.

Most readers of the Journal will doubtless have derived their ideas of modern Japanese Agriculture from the note by Sir F. A. Nicholson, reviewed in this Journal (Vol. III, part I) by Mr. E. Shearer. The note above mentioned, however, dealt more or less with the existing conditions of to-day : the present volume is retrospective as well. It is divided into 3 parts, which deal respectively with the conditions, past and present, of Agriculture in Japan, Agricultural Products, and Agricultural Administration, and in an extremely concise manner (so concise as to be occasionally rather bald) it presents us with both the results and the methods of twenty years evolution of Japanese Agriculture.

The progress of agriculture in any country may fairly be estimated by the extent to which improvements in tillage, seed

* "Outlines of Agriculture in Japan" published by the Agricultural Bureau, Department of Agriculture and Commerce, Tokyo, 1910.

selection, manures, implements, and live stock have taken place, resulting in an increase of the total acreage under cultivation, an enhancement of the total produce and of the yield per acre, an improved quality of the produce, and a rise in the prosperity of the agricultural population. Judged by these standards the agriculture of Japan, as described in part I of the book, has made striking progress during the last 20 years.

According to the table on p. 37 the areas of the principal crops cultivated have increased during the period 1887-1907 as follows :—Rice 10%, barley 5%, naked barley or rye 21%, wheat 12%, soy-bean 1%, buckwheat 5%, sweet potatoes 30%, and potatoes 28%. In addition to these purely agricultural crops mulberries have shown the striking increase of 69%, millets, cotton, and indigo have declined, owing to foreign imports and artificial production, but to take their place fruit, vegetables, pea-nuts, peppermint, and other minor crops have increased in area.

These striking increases have been brought about by active governmental measures fostering reclamation of land, irrigation, drainage, and what is called adjustment of farm lands. The latter work is, perhaps, the boldest of all the schemes which have been tackled by the Government in Japan, and it speaks much for the perspicuity of those at the head of affairs that they realized that it lay at the foundation of agricultural progress. The arable land of the country is parcelled up among holders whose average holdings are not more than 2·45 acres in extent, the holdings themselves being often subdivided, with the sub-divisions not contiguous to each other, and forming, as in many parts of India, a network of minute, irregularly shaped fields. Under such conditions improvements in the direction of improved implements, irrigation, drainage, etc., are difficult and often impossible; and accordingly, in 1899, laws were made in Japan encouraging owners of land to consolidate their holdings, straighten the boundaries of their fields, and provide roads and other conveniences. In taking these measures "the Government expected to lay a perfect foundation for agricultural undertakings both at present and in the future, . . . the investigation made at

the end of the year 1909 shows that the area of the land thus adjusted throughout the country has reached 178,000 *cho*" (about 490,000 acres). The work, however, is naturally very slow, and as yet about $\frac{1}{10}$ only of the paddy fields have been so adjusted. These measures, however, mark more than anything else, the *thoroughness* with which the improvement of agriculture has been tackled, and should furnish a useful object lesson to all who have realized that the scattered, irregular, and minute fields of the Indian cultivator form a very real bar to progress. In his note Sir F. A. Nicholson, speaking with special reference to Madras, has the remark that possibly as "Settlement and Survey work proper declines, the 'Verkoppelung' of scattered plots will employ the parties," but he suggests that it would be far better for the village associations to carry out the work themselves. In whatever way the desired result may be brought to pass, it must come before *real* progress can be made. No less than the consolidation of holdings the construction of regularly shaped fields, with roads at proper intervals, and affording facilities for irrigation, drainage, and the use of improved implements, is just as crying a necessity in many parts of India as it is in Japan.

The work of irrigation and drainage has also shown remarkable progress. Historical records show that irrigation was a subject that received much attention from the rulers of Japan even at remote periods in its history. This policy has been continued, and in recent years steam and electricity have been adopted "by the united efforts of farming communities" to pump water into the paddy fields. In March 1909, there were 79 places where mechanical irrigation devices on a large scale were employed. In addition to irrigation, the drainage of paddy fields has received much attention during recent years. It is common to raise winter crops after the harvesting of the paddy, but in many places it was found impossible to do so, owing to the high level of the underground water. Accordingly, recourse has been made to drainage, either the open or underground system being employed, and where natural drainage has been found impossible, mechanical devices have been brought into use . . . . .

"According to investigations made in March 1909 there are 47 places where provisions for mechanical drainage are adopted, and the area of the land drained off reaches 7,500 *cho*" (1 *cho* = 2·45 acres). The book does not give details as to the pumping apparatus used for the purpose, but a photograph illustrative of it is shown at page 20. These extensions of drainage and irrigation have, needless to say, been much facilitated by the adjustment of lands above described.

In the introduction and use of artificial manures great progress has been made in quite recent years. The Japanese cultivator is naturally a careful economist, and from time immemorial has husbanded with scrupulous care such fertilizers as he found ready to hand. Twenty years ago, we are told, human excreta was, as it still is, the great natural manure. Weeds, farm manure, and ashes of plants were regarded as manures of comparatively inferior quality, and among manures purchased were oil cakes, fish guanoes, and rice bran, but the three latter, we are told, were little used then. At the present day the principal artificials are, in order of value consumed, soy bean cakes, superphosphate of lime, mixed artificials, rape seed cake, herring cakes, bone dust, cotton seed cake, and the total average consumption per annum for the three years 1905—07 amounted, for the whole country, to about 38,000,000 *yen* or nearly 570 lakhs of rupees. Superphosphate has attained to remarkable importance as a manure, the phosphate rock being apparently imported and the manufacture of the manure done in the country.

One turns with considerable interest to what is said on the subject of agricultural implements, expecting to find commensurate progress with that effected in manures. It is rather disappointing to find no details given, but such, however, would probably be without the scope of the book, which is meant to give a general outline only. The intensive nature of Japanese agriculture seems to have made the introduction of large and modern European or American implements impracticable, and the implements used at the present day are still mostly of wood. Within recent years, however, it seems that inventors of new

agricultural implements have not been wanting and that over 400 patents have been granted for models which are "quite adapted to practical purposes." From the Indian point of view it would have added considerably to the interest of the book if photographs of indigenous or improved Japanese implements had been supplied.

A table on page 39 gives the outturns of the principal crops per "tan" for the years 1887, 1892, 1897, 1902, 1907, the figures given for each of the above dates representing the average outputs of the five preceding years. With the single exception of cotton, all the crops showed a marked increase in output and in the case of the principal crops this is strikingly exhibited. Thus rice has increased by about 23%, barley by 36%, "naked barley" or rye by about 10%, and wheat by about 28%. If these figures are reliable, they offer a convincing proof of the success which has attended the introduction of improved agricultural methods during the last two decades.

The second part of the book deals with agricultural products. The description of the cultivation of the principal crops is too short, and might with advantage be expanded if further editions of the book are contemplated. The accounts given of the silk and tea industries are somewhat fuller and are accompanied by excellent photographs. In the same part the animal industry and several small subsidiary industries engaged in by the agricultural population are dealt with.

In connection with the animal industries a determined effort is being made to improve the breeds of cattle both for beef and milk purposes, and foreign bulls have recently been largely imported. No account is given in the book of the indigenous cattle of the country. In the case of horses we are told that "various lords in the Feudal times issued regulations regarding horse affairs with a view to the improvement of breeding. The result has proved to be perceptible . . . . . . in the case of the Nambu-horse." A committee for the investigation of horse breeding was formed in 1896 as a result of the war with China and worked under the control of the Department of Agriculture.

It established horse breeding depôts and imported stallions. After the war with Russia in 1904-05 the subject of the supply of military horses was realized to be so important that a special Horse Administration Bureau was formed which is under the direct control of the Cabinet.

In Japan there is no native breed of sheep, but apparently they were imported (we are not told from where) some forty years ago, and an American expert brought over to instruct on sheep farming. This attempt was unsuccessful, but in recent years they have been acclimatized. Several breeds of goats exist in Kyushu, and apparently other breeds have been recently introduced. Swine and poultry receive attention at the Imperial Stock Breeding Farm at Tokyo, and poultry farming as a subsidiary industry to agriculture has shown an encouraging development of late years.

The subsidiary occupations are a great help to a community of small holders such as the Japanese are, and are undertaken by such members of the household as can be spared from the ordinary labours of the farm, or they occupy the time of the farmer during slack seasons. The principal are straw and chip braid-making, straw matting, ropes, bags and sandals, fancy mat-making, weaving, the manufacture of paper and of various articles from bamboos and osiers, bee culture which has been in existence from very ancient times, and the culture of carp in specially constructed ponds or in the paddy-fields as an adjunct to the cultivation of the latter crop.

The third part of the book deals with agricultural administration, and describes concisely the administrative and executive machinery which have effected the progress sketched in Parts I & II. It has a chapter on the history of agricultural development and the bureau of agriculture, another on the organs of agricultural investigation, which describes the Imperial Agricultural Experiment Station, Local Agricultural Experiment Stations, the Sericultural Institute, the Conditioning House, Stock-breeding Farms, etc. Another chapter deals with agricultural education and gives a succinct account of the agricultural

college of the Imperial University, higher agricultural schools, ordinary agricultural schools, agricultural institutes and supplementary schools, lectures and peripatetic instruction. A further chapter describes what has been done in the way of formation of agricultural societies, co-operative societies, staple product guilds, rice inspection systems, rice depôts, the sugar improvement office, shows and exhibitions, and agricultural banks.

Most of the details connected with administration, education, co-operation and credit, and other aspects of agricultural development, have already been presented to Anglo-Indian readers in Sir F. A. Nicholson's note. The present volume possesses some extra interest in that it gives a short historical account of that development—an aspect of the matter of supreme interest to us in India, where systematic agricultural work may be said to have only just begun. The author of the book divides Japan's agricultural development up to date into four distinct periods :—

1. The thirteen years from 1868 to 1880.
2. The ten years from 1881 to 1890.
3. The fifteen years from 1891 to 1905.
4. From the year 1905 to the present.

The first period was that of Japan's awakening, when Western ideas in all departments of life were being feverishly copied. Agricultural experts were invited from abroad, and new and improved varieties of crops were introduced and distributed. The result of this period, which has a parallel in the agricultural development of practically all countries, and which might be designated the period of the enthusiastic amateur, ended in failure. Government interference in these matters was deprecated by the people themselves, and among even the more intelligent class the policy of *laissez faire* in agricultural matters was advocated. Failure resulted, as it was bound to result, because in the first place no definite branch of the administration was specialized to deal with agricultural matters; and secondly, because the people themselves were poor, ignorant, and lacking in enthusiasm.

The second period, 1881-1890, was marked by the creation in 1881 of a Department of Agriculture and Commerce, with a special Bureau of Agriculture. Successful development dates from that year. The new department fostered shows, conducted agricultural experiments, appointed circuit instructors to influence the masses, and in stock-rearing, sericulture, and other matters, made a good beginning. As yet, however, it had not, to use a phrase much employed in India, "got at" the people.

It was in the third period that the important problem of getting at the people, of bringing a nation of poor small holders into organic connection with the government, was successfully tackled and solved. The beginning of the period was marked by the opening of the Imperial Parliament, which at once instituted a bold and progressive policy in agricultural matters. In 1893 the Imperial Experiment Station at Tokyo was founded, followed by the Sericultural Institute. The war with China gave an added impetus to the work, demonstrating as it did the necessity for husbanding and utilizing in the most economical manner the national resources. Agricultural banks were founded, experiment stations were more highly subsidized, and laws for the adjustment of lands and for the formation of agricultural societies, and of co-operative credit societies, were passed in rapid succession. The period ended with the Russian war in 1904. Its outstanding features were undoubtedly the introduction into agricultural policy of the two features of co-operation and credit. In 1900 Government issued the rules for the regulation of agricultural societies, realizing, apparently, that any attempt to get at individual cultivators was not likely to prove successful. These societies are of three kinds—prefectoral societies, county and city agricultural societies, and town and village societies. County societies consist of the town and village societies of the county, and prefectoral societies consist of the county and city societies in these districts. When two-thirds or more of a community voluntarily form a society the remainder are regarded by the law as joining the association.

The societies pay their own expenses, but subsidies are received from the exchequer and from local and county funds in order that they may carry on extra works. Their objects are :—To establish farms or nurseries for seeds and seedlings, especially of rice and mulberries : to conduct lectures and demonstration : the introduction of new varieties and new methods of cultivation : the creation of co-operative credit societies to act as mediators for joint purchase and sale : to collect statistics, to encourage subsidiary industries, exhibitions, sericulture and stock-farming, and to publish society reports. Their functions in short somewhat correspond to those of the various agricultural societies which are a common feature of European agriculture. The success of this movement may be gauged from the fact that the number of village societies now totals up to nearly twelve thousand.

In a nation of small holders with small individual capital, more, however, was required. Accordingly the Co-operative Credit movement was started in 1900. It also has met with an equal measure of success. Credit societies have as their aim "to supply capital at a low rate of interest to persons under the middle class, to accelerate mutual profits, and to make economic and productive developments." They are of four kinds :—

(*a*) Credit societies for the advancement of capital and to facilitate savings.

(*b*) Sale societies—to effect sales of articles which may or may not be finished.

(*c*) Purchase societies—to purchase articles necessary for productive industry for the members of the society.

(*d*) Productive societies—to finish articles which have been partially produced by members, or to furnish members with articles necessary to their industry. Members of these societies are exempt from income-tax and can have funds from local hypothec banks without the deposit of securities. The societies have now reached the total of 5,500, and have at their command a capital of 40,000,000 yen or 600 lakhs of rupees. The societies have further confederated themselves : thus there exists a

confederate association of credit societies, and one each of sale, of purchase, and of productive societies.

It is impossible within the scope of this article to enlarge further on the work done by the Japanese government. The success achieved undoubtedly rests on the application of the two great principles of co-operation and credit. The experience of Japan proves clearly that scientific research and education, all important as they are as factors in agricultural improvement, must go hand-in-hand with co-operation and credit. The great problem in India, as it is in Japan, is to "get at the cultivator." The account given in the book under review has proved decidedly that co-operation plus credit is *the* method of doing so. Research and agricultural education accompany as powerful auxiliaries. It augurs well for success in India that the policy being adopted here is substantially that adopted with so much success by Japan. Whether an equal measure of success will be achieved remains to be seen. Behind all governmental measures and policies there must exist the greatest factor of all—national character—and the progress depicted in the pages of this little book, achieved concurrently with victory in two great wars—speaks wonders for the courage, determination, and patriotism of the Japanese people. We would gladly welcome a second and enlarged edition of the book. Despite its literary defects, which are quite excusable and easily remediable, it has fulfilled its object of "acquainting the foreigner" with what Japan has done. The statement of success which it records must have caused the department which has issued it a good deal of quite pardonable pride.

EXOTIC COTTONS IN SIND.

By G. S. HENDERSON, N.D.A., N.D.D.,

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I—Egyptian Cotton.

As it will in all probability be possible to sow Egyptian cotton in 1912 on the Jamrao Canal, attention is invited to the following precautions which, in the opinion of the writer, it is necessary to secure—

(*a*) Proper cultivation including sowing before 1st week in April, avoiding "*kalar*" ground, and if possible, growing in rotation with *berseem*.

(*b*) The provision of a system for disposal, ensuring proper treatment after marketing seed cotton and for ginning, grading and selling at current market prices.

In order that the cultivation shall be properly supervised, it would be advisable to appoint two *mukhtyarkars* on special duty, one for the north of the Jamrao and one for the south, to be under the immediate orders of the Agricultural Department. They would begin work at the beginning of 1912. Their duties would consist in seeing that the cotton seed was properly distributed and that suitable land was cultivated. They would continue on duty till picking time when they would take charge of one sub-station each for the collection of the cotton.

The cultivation of the plant is by far the simpler part of the problem. It was not long since an area of 6,000 acres was obtained mainly by the influence of the Colonisation Officer, Mr. Chatfield. The disposal of the produce, however, is a more difficult matter. Formerly two varieties of cotton were grown,

Abassi and *Mitafifi*. These were collected from the cultivators in sub-depôts and sent to Mirpurkhas in different lots and sold by auction. There were always considerable variations in the quality, cleanness and value of the different lots, but for the first few years very fair prices were obtained. The buyers were of two classes :—

(*a*) Mill-owners from Ahmedabad and Bombay.

(*b*) Exporters from Karachi and Bombay.

The mill-owners, several of whom use imported Egyptian cotton, soon stopped coming. They complained that when they bought Egyptian cotton in Alexandria or Liverpool they got a certain grade, *e.g.*, "Fully Good Fair," which was uniform and could be depended on to produce certain "counts." Whereas for Sind Egyptian, they had to send their agents to Mirpurkhas at an unhealthy time of the year and not knowing Sindhi language were at a great disadvantage. To buy any quantity, they had to bid for a number of small lots, some dirty, some stained and some good. These they had much difficulty in getting ginned as the local gins which are only suited for short staple cotton had plenty of work of their own. There does not, therefore, seem to be the least chance of mill-owners taking the cotton direct from the cultivators; on the other hand, they would probably use a considerable quantity if an assured supply of baled and graded cotton was available. A mill-owner is not a cotton broker and the cotton broker is an essential link between the cultivator and the user of the cotton. An Indian cotton broker has no knowledge of Egyptian cotton as a commercial knowledge of one kind of cotton takes a life-time to acquire. A sample of "Fully Good Fair" *Mitafifi* submitted to a leading Bombay exporter was stated to be a "foreign variety of a bad colour!"

As regards the exporting firms, they always fought shy of *Mitafifi;* and one firm got "its fingers burnt" by sending a consignment of so-called *Abassi* to Liverpool. It had never been properly cleaned and was full of dirt and pieces of leaves. Naturally it was unsaleable. It does not seem probable that Indian export firms will take up an entirely new and unproved

branch while they have as much work as they can possibly do with existing cottons.

Carefully taken average samples of *Abassi* and *Mitafifi* have been forwarded to three leading Alexandria brokers during the last few years. Their verdicts are very important and are all unanimous to the effect that the *Mitafifi* is of a good strong and useful quality, but that the *Abassi* would never grade as such in any market. The *Mitafifi* has been up to the standard of "Fully Good Fair," which is to say, if properly cleaned, properly ginned and baled and sent to Liverpool, it would fetch the current price for "Fully Good Fair" Egyptian brown. It is not to say, however, that if passed through an "opener" badly cleaned or crushed while ginning in a gin meant for Indian cottons, it will reach this grade. There is no sale for *Mitafifi* in India; it is nót used and its colour is against it. It will, therefore, be necessary to export it. As for *Abassi* it is quite useless to continue it, as it is not up to export quality; and though it might be sold in India as a miscellaneous cotton, it would probably not yield as well as ordinary Upland American in price and produce. The cultivators on the Jamrao generally hold what experience has already taught in Egypt, *viz.*, that *Mitafifi* is hardier all round than *Abassi*. However, as *Abassi* has always brought a high price at the auctions, the cultivators have generally elected to grow it.

Briefly then if the above proposed scheme for superintending the cultivation were adopted, after harvest the cotton would be gathered in a few conveniently selected sub-depôts. Only clean cotton would be accepted and one uniform grade of *Mitafifi* would be produced. Two alternatives are then possible: (a) that the British Cotton Growing Association be asked to step in at this stage and clean, gin, export and sell the cotton, or (b) that Government, by means of the existing Agricultural Department, should buy the crop outright, export and sell it for a few years to see if local firms will then take it up. The first is by far the simpler method and if a good area of, say 10,000 acres *Afifi* could be guaranteed, it would be worth the trouble of the British Cotton Growing

Association to send an experienced agent to take over the cotton at Mirpurkhas and to clean, gin, bale and export it. Arrangements could be made to get half the value paid to the cultivators on delivery at the sub-depôts, and the remainder after selling at Liverpool.

The writer is very strongly of opinion that it would be much better to stop the cultivation of Egyptian cotton altogether, if it is not proposed to provide means for the disposal of the produce. Provided the cultivator gets Rs. 12, or over per maund of 81 lbs. for seed *Afifi*, it will be more profitable in average years than cultivating Sindhi cotton. The average yield under fairish cultivation may be put down at 5 maunds per acre ; under similar conditions the yield of Sindhi cotton might average 7 maunds at Rs. 6 per maund.

II—American Upland Cotton.

From fairly extensive trials it is now certain that a good class of American cotton can be produced under average circumstances in Sind. It has the following advantages for general cultivation :—

(*a*) Short growing period, shorter than Sindhi, and thus it can be sown on inundation canals. There is consequently a very large area on which it can be grown.

(*b*) It is hardy, but is easily affected by "*kalar*" and on lightish land it suffers severely from white ants.

During the past year, some good yields were obtained, and in many cases it produced as much seed cotton as neighbouring plots of Sindhi. In other places, however, it suffered from white ants or "*kalar*." The reports from Liverpool brokers were good both as to quality and ginning percentage. They stated that it was exactly the stuff required by Manchester and that they could take it in any quantity.

The disposal is the difficult point. Local buyers do not seem to care about dealing in it, and in some cases growers last season mixed it up and sold it as Sindhi. Very little seed was distributed to zemindars this season, though many applications

were received for the above reason. During the present season, American cotton is growing at the following places :—

In Upper Sind where practically no cotton is at present grown.	Jacobabad. Shikarpur. Sukkur. Ubauro.
In Lower Sind	Noushahro Feroz. Nawabshah. Halla. Nara Valley. Mirpurkhas. Hyderabad. Tando Mahomed Khan. Talhar. Phuleli Escape.

This only leaves out Larkana and Karachi districts where for want of necessary staff it is not under trial. Provided that results from the above centres are successful, it will be necessary to arrange some means of disposal before any extension of the cultivation in the districts can be contemplated.

The difficulties pointed out with regard to Egyptian cotton apply also, though in a somewhat less degree, to American cotton. If the British Cotton Growing Association can be persuaded to take up the disposal of Egyptian, they could at the same time deal with the American cotton crop. For season 1912, a considerable area of cotton could be guaranteed, as there is a large area to take in Upper and extreme Lower Sind which, at present, grows practically no cotton at all.

If it is not possible to arrange in the way as suggested above by the writer, the only alternative will be to sell it departmentally. It is very necessary to fix some scheme for disposal, otherwise it would be much better for the agricultural staff in Sind to devote its attention to the subject of the local Sindhi cotton and to leave the exotic cottons alone.

SOFT ROT OF GINGER IN THE RANGPUR DISTRICT, EASTERN BENGAL.

By WILLIAM McRAE, M.A., B.SC.,

Supernumerary Mycologist.

Soil.—For the successful cultivation of ginger, light, sandy loam or loam that is well drained is necessary. On clay the crop does not thrive because of the greater amount of water retained in and on the soil. The rhizome does not form well, and the chances of its becoming diseased are greater in places that suffer from damp or where water is stagnant. Ground that has remained fallow for three or more years, having usually become over-run by thatching grass is in this district generally chosen as the site for a ginger crop; and the field, after bearing a single crop, is not again planted with ginger for a period ranging from three to ten years, though five years is a common time. This long interval is said to be necessary partly because the crop is an exhausting one on the food-content of the soil and partly because it is so liable to disease when planted more often.

2. *Cultivation.*—As good drainage is one of the most important considerations for the successful cultivation of a ginger crop, great care is taken to prepare the soil and ensure that water does not stagnate. The land is spaded, ploughed, cross-ploughed and hangered till it is brought to a fine tilth, so that the roots may easily ramify in the soil and so better procure the plant-food available. Then the field is divided into parallel beds seven feet wide, separated by channels one and a half or two feet wide and eighteen inches deep. Besides these, in well-cultivated fields there is a drain about two feet deep all round the field, for the purpose of carrying off the water from the parallel drains, which communicate with it. The ginger "seed"

is planted across these parallel beds in rows about one and a half feet apart. A light plough is drawn by hand to make a shallow furrow two or three inches deep and in it the seed is planted, each piece about four to eight inches apart. The earth is then closed evenly over the furrow. In a month or six weeks the plants have sprouted and, when they have grown about six inches high, one earthing is made. The field is kept thoroughly clean of weeds and one, or at most two more earthings may be required, so that finally the ginger lines are converted into ridges and the places between the rows of plants become furrows, which lead drainage water into the parallel drains. In this way a perfect drainage is assured in the field. Nothing more is required till the time of harvest except to keep the field clear of weeds.

3. *Curing.*—The crop is generally harvested from January to the end of February. If, however, the price of ginger is high, the cultivator will take up his crop any time after October. When dug up the mature rhizomes are cured. After being washed and having the small roots picked off they have the outer corky rind scraped or removed and are laid out on mats in the sun to dry. They are turned once or twice each day for about a week, when the ginger is quite dry.

4. *Area under ginger in Rangpur.*—The area under ginger in Rangpur district is not definitely known. In the forecast for *rabi* crops from Nelphamari, the largest ginger-growing sub-division in the district, 1,000 acres are put down under *rabi* non-food crops, the area of individual crops not being specified. Fully two-thirds of this area may be taken as under ginger: so the area in Nelphamari is about 700 acres. For the other three sub-divisions 800 acres is a fair estimate. Thus the area under ginger in Rangpur district is about 1,500 acres.

5. *Jaindhara disease.*—The ginger seed is planted out in March and by the middle of August or September, the plants are about $1\frac{1}{2}$ feet high. Then a disease, locally known as Jaindhara, begins to manifest signs of its having attacked the plants. (Vide *frontispiece.*) Year by year this disease attacks the crop and

has done so for several years. A few of the young leaves become yellow and begin to die in the month of July, and by the middle of August the disease is spreading rapidly. The expert cultivator easily recognises the disease and knowing by experience that it is infectious removes from the fields as soon as possible the yellow leaved plants which have become rotten. The removed plants are thrown into an out-of-the-way corner and left to decay. This process of removal goes on till the end of September, when it is discontinued, and the diseased are allowed to grow with the healthy plants till well on in November, when they are partially mature. They are then dug up and sold off in the market at whatever price they will fetch. The healthy plants remain in the field and are harvested later, up to January, or February. Partially diseased rhizomes being discoloured, soft and watery, do not cure well and the outturn when cured is small, while badly diseased ones are useless.

6. *Active period.*—It may be noted that the disease appears with the advent of the rains and becomes epidemic only when the rains have fairly well set in and the ground is wet. In damp fields where the soil is stiff and retains water the attack is always more severe, while on sandy loam the disease does not usually reach an epidemic stage. When the rainy season is about at a close, the removal of diseased plants ceases and any later attacked plants are allowed to remain in the ground to do what they can before being finally taken up and sold as inferior-quality ginger. The cultivator has learned by experience that, after the rainy season is over, there is little fear of the disease spreading much.

7. *Damage.*—The disease is widespread throughout the district, and it would be difficult to find any considerable acreage where it is not present. Even taking a low estimate the loss runs into a good many thousand rupees. Near Surat in 1904 in one village alone, visited by Dr. Butler, the loss was estimated at 10,000 rupees. The damage is always more marked in damp soil where there may be a yearly loss of 10 to 15 per cent. of the crop, while in dry soil the disease appears only in patches and the loss may be 5 or 6 per cent. If, however, in a wet year the

diseased plants are not removed as soon as observed and the crop is allowed to grow with little care, the whole crop in a damp field may be all but lost. In a three-acre field near Kanail Khata, in the Nelphamari subdivision, the ginger grew on a site that had not borne ginger for many years. The soil was a sandy loam and the plants had been kept free of weeds. About twenty per cent. of the plants showed signs of disease. Here the dying plants had been pulled up by the collar and thrown down in the furrows but no attempt had been made to remove infected rhizomes. The cultivator was trying to check the disease but had not gone far enough. About a mile away another field which had been uncultivated for, it was said, fifteen years had about 80 per cent. of the plants diseased at the end of September. The soil was not well cultivated and was badly drained, and the cultivator had done nothing to try to stop the disease. Healthy and diseased plants were growing side by side, the latter gradually infecting their neighbours. This apathetic attitude with regard to the disease is not, however, general. Cultivators know the disease quite well and try to overcome it by planting good seed only and by removing the visible parts of the decayed plants, but not knowing the cause of the disease nor its method of spreading, their precautions are not thorough enough. They do not dig up and remove the diseased rhizomes as soon as they are affected nor do they realise the necessity of destroying the affected parts. It is a too common practice, when harvesting the crop, to leave diseased rhizomes in the ground as not being worth lifting. Single plants or whole patches are often left. They slowly decay and keep the fungus causing the disease alive for a long time. Thus it has come to be the usual and necessary course not to grow a ginger crop in the same field till after the lapse of several years.

8. *Rangpur Experiments.*—No ginger crop is grown in the immediate neighbourhood of the town of Rangpur, but on the Experimental Farm under the management first of the Agricultural Department and then of the Agricultural Association of Rangpur, experiments in ginger have been made annually since 1905-06.

Small plots of ginger from the four localities, Jamaica, Cochin, Calicut, and Bengal, have been grown. All the plots were attacked by disease and rather severely in 1907. "As a preventive against the disease precautions were taken when harvesting the crop to remove all the rhizomes from the soil and those which showed any signs of disease were destroyed. The new crop was planted as far away from the site of the old crop as possible, and as far as could be ascertained by the eye, only healthy seed was used for planting."* In August 1908 only a few of the plants manifested signs of disease. All the four varieties had the disease and it increased slightly as the season advanced. The weather had been rather unfavourable to the development of the disease, as it remained dry up to the beginning of this month. The plants were slightly below the normal height of an ordinary season. In the previous year at this time the disease had attacked a large proportion of plants. Jamaica ginger imported and grown in the previous year almost succumbed, scarcely yielding more than enough for seed for this year. When planting for the 1909 crop similar precautions were taken and the seed was chosen most carefully. In October towards the end of the rains not a single diseased plant was found, though a sufficiently large number of plants were dug up and dissected to make sure. An insect pest, however, was doing a good deal of damage to the shoots. It was the larva of a Drosophelid fly which lives on coarse grasses. It probably came from a piece of jungle close by, where part of the refuse of the town was being conserved.

9. *Symptoms of disease.*—The first outward indication of the disease in the growing crop is a general but slight paleness of the leaves of a shoot, then the tips of the leaves turn yellow, and this yellowing gradually spreads along the leaf towards the leaf-sheath, often more rapidly along the margins. Then the leaf-tissue dies and becomes scarious from the tip, the dead area gradually extending towards the leaf-sheath following in the wake of the yellow discolouration. The leaves droop and hang down

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* Annual Report of the Agricultural Stations in Eastern Bengal and Assam for the year ending 30th June 1908, page 30.

along the stem, till finally the whole shoot becomes dry and withered. Meantime the collar, that part of the aërial stem between the place where it arises from the rhizome and where it emerges from the ground, becomes of a pale, translucent brown colour and, by the time the leaves are well yellowed, it is very watery and soft so that the whole shoot can easily be lifted off, breaking away at this point, though not falling over spontaneously. This soft rot also extends beyond the collar into the rhizome. The rotting is accelerated by the combined action of other fungi and of small eelworms and the larvæ of flies which act as secondary agents. Both the discolouration and softening extend to the whole rhizome which gradually rots and disintegrates forming a loose watery mass of putrifying tissue enclosed by the tough rind. The vascular strands lie isolated inside. The roots attached to the affected parts also present the same symptoms. (Plate XXIII.)

10. In 1902 Dr. Butler, Imperial Mycologist, observed* a disease of ginger plants near Surat in the Bombay Presidency* identical with this one in Rangpur, and it has also been reported from Nadiad. He found *Pythium gracile* commonly in the diseased portions of the rhizomes and lower parts of the leaf sheaths, and this was the only fungus found in the interior of the stem in the early stages of disease. It was in most cases but not always associated with eelworms. This fungus was also invariably present in the ginger plants in Rangpur. Here, too, eelworms were often present even in slightly diseased parts but several examples were found with the fungus alone present, and it is believed to be the cause of the rot. Slabs cut out with a red-hot knife from the interior of stems that were only slightly diseased and grown under aseptic conditions gave pure cultures of *Pythium gracile* only. On dissecting many plants, examples were found that pointed clearly to the infection having come from the planted sets and this seems to be the method chiefly responsible for the introduction of the disease into the growing

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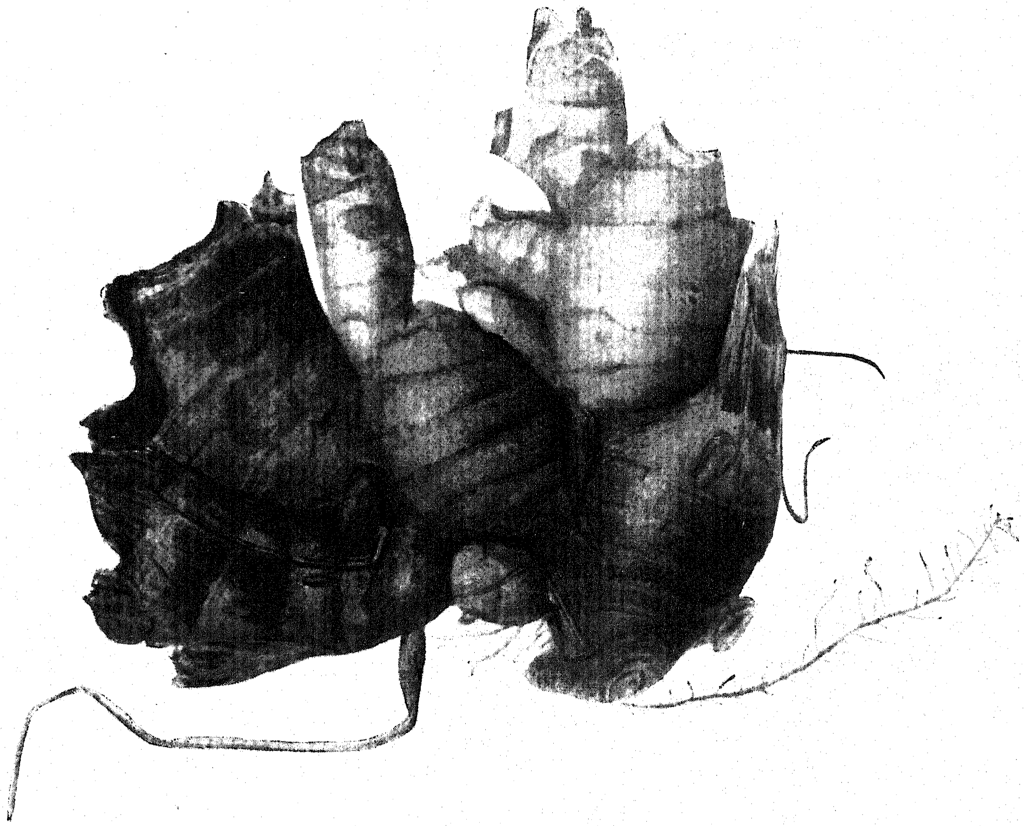
* Memoirs of the Department of Agriculture in India, Vol. I, 1906. Pages 16, 68, 70.

PLATE XXIII.



A. J. I. RHIZOMES PARTLY DISEASED.

crop. Several cases were found where only a very small part of the current year's rhizome was diseased. Young buds still underground or just above ground were found to be diseased, the infected portion being isolated and extending inwards only a very short way. A connection was also traced between an affected shoot and an adjacent bud below ground that had been destroyed by disease. Under the microscope the hyphæ of the fungus were seen ramifying in the cells of the discoloured portion, and their tips extended into the living cells of perfectly healthy tissue. There is then little doubt but that this fungus is parasitic. The planted sets from which these affected buds spring were quite free from disease. They were not discoloured nor were hyphæ seen in section either in the neck connecting the old and new rhizomes or in the old rhizomes.

11. To make certain that the fungus *Pythium gracile* is the cause of the disease it is necessary to produce the disease in healthy plants after inoculation with a pure culture of the fungus. Such infections have not yet been carried out successfully. For this reason we cannot be certain that *Pythium gracile* is the cause of the disease. Still with the experience on the Rangpur farm, we are in a position to make the following recommendations to check the disease :—

1. On harvesting the crop all the rhizomes should be removed from the ground. Diseased ones ought never to be left on the ground. They should be collected with as many of the roots attached as possible and burned or buried deeply in a place where ginger will not be grown. The shoots of diseased plants should also be gathered and burned.

2. Ginger should not be grown on the same land for at least three years. As there is plenty of available land, in Rangpur District at least, this should not be a difficulty.

3. The seed should be got from a place that is free from disease. Great care should be taken to ensure that the seed is healthy. Yet it is not always possible to recognise by the naked eye alone the early stages of disease in a rhizome. If any of the buds are bad the whole piece should be suspected and discarded.

4. Whenever disease occurs in a field, the affected plants should be dug out whole with the larger roots attached and should be destroyed by fire. It is not enough to pull the shoot off by the collar. The rhizome must be got out too. By breaking the shoots off at the collar or by detaching the larger roots an opening is given for liberating the infection into the soil. Infected plants should never be thrown down in the field to rot but removed to the edge of the field and burned.

5. Water should never be allowed to lie or stagnate in a ginger field. Air and water should be able to move freely in the upper layers of soil, surrounding the tubers. Fortunately, as mentioned above, cultivation and drainage is well attended to, as a rule.

6. Till the disease has been further investigated, these precautionary measures will suffice to keep it in check. They have acted very well at Rangpur Farm, where in two seasons the amount of disease was materially reduced.

TWO INSECT PESTS OF THE UNITED PROVINCES.

By T. BAINBRIGGE FLETCHER, R.N., F.E.S., F.Z.S.,

Offg. Imperial Entomologist.

THE very idea of such a subject as Economic Entomology is still such a novelty in the eyes of the Indian agricultural classes that little general progress has been made in the adoption of preventive measures against insect pests as part of the ordinary routine of agricultural operations. The life-history of even the commonest and most destructive insect is generally a closed book to the very class of men most vitally affected by their want of knowledge. The fact that a moth lays eggs may be known as the result of more or less idle observation, but that the moth and the eggs may have any relation to the caterpillars which presently swarm everywhere and devour the crops is, generally speaking, a matter undreamt of in the cultivators' system of philosophy. It is necessary, then, to start from the very beginning, to point out the damage wrought by insect pests and to devise simple methods of minimizing the damage done by them. It is very important to bear in mind that the remedies adopted, to be suitable to Indian conditions, must be simple and cheap: they must harmonize with the conditions of the local agricultural practices and must not involve the use of any expensive apparatus or insecticides. Granted that these conditions are fulfilled, it still remains to get the cultivator to apply the remedies for his own benefit, but, generally speaking, he is shrewd enough to make use of them once he is convinced of their utility. Occasionally some difficulty is experienced on account of a real reluctance to take life even in the case of insects avowedly destructive, but a certain measure of *vis inertiæ*, coupled with a

natural suspicion of anything new, is commonly the greatest difficulty in the general adoption of more scientific methods.

There is little that is new in the following paper, which was prepared for and read at the Agricultural Conference at Allahabad in January of this year. It deals with only two pests, neither of which is confined to the United Provinces; on the contrary, both are distributed over nearly the whole of India, and the first (the Cane Grasshopper) does immense damage to rice crops in some districts. The main point dealt with is the necessity for co-operation and an appeal for this is addressed chiefly to those members of the landed classes who read these lines. We are willing and eager to help the agricultural classes throughout India to obtain the full benefit of their labours; the difficulty is the diffusion of knowledge owing to the scanty number of workers and the immense areas to be dealt with. What can be done with the present staff is being done, but still more can be accomplished if the larger land-holding classes will help in spreading a knowledge of the life-histories of insect pests and of simple preventive measures to be used against them.

The subject of the following paper is that of some insect pests of crops and the best methods of dealing with them. The agriculturist's ideal has been defined as the making of two blades of grass grow where one grew before. This may be the height of his ambition, but actually his end is to obtain a larger produce, crop, profit—call it what you will—from the ground. The aim of the entomologist is to help the agriculturist by seeing that he gets this increase and that his profit is not destroyed by undue tolls levied by destructive insects on the crops before or after harvesting.

Every plant that grows is attacked by some insects, often by many, and it usually happens that the insects found on any particular wild plant are especially attached to that plant and will not eat any other. This fact is very important in considering the increase of such an insect, because of the difficulty of its finding a sufficient quantity of its favourite plant in one place. In the case of crops, this restriction is removed, so that an insect

which feeds on a cultivated plant, such as sugar-cane or potato, finds abundance of its special food and in the absence of efficient checks is able to multiply until it seriously affects the yield of the crop, when we begin to speak of it as a pest and look around for the best means of combating its attack.

Now, the first point to be considered in dealing with remedies for a pest of this sort is the necessity for a knowledge of its life-history. If we know exactly when and where the eggs are laid, when they hatch, when the perfect insects emerge and, generally speaking, if we know exactly what the insect is doing at any particular time in any particular place, we then have the information which will probably enable us to put our finger on the weakest place in that insect's economy. This is the work of the entomologist, who makes it his business to recognise the insect, to know which insects are the most destructive and what are the best methods to use against them.

The Cane and Rice Grasshopper.

The first insect pest which I shall deal with is the sugar-cane grasshopper, whose life-history is as follows:—

The eggs are laid as the land dries up after the rains, *i.e.*, at the beginning of the cold weather, and remain dormant in the soil until the beginning of the next year's rains. As soon as the rains commence and moisten the soil about the end of June, the eggs hatch out and the young hoppers make their way up through the soft earth.

The young hoppers on emerging from the egg are about a quarter of an inch long and of a greenish yellow colour. At first they feed on any tender vegetation which they find close at hand, especially small millets such as *sawan* (Panicum frumentaceum), *mandua* (Eleusine coracana), *kodon* (Paspalum scrobiculatum), and *kangni* (Setaria italica) gradually working their way along the ground away from the place where they hatched out until they come across a field of young cane, or some similar situation with an abundance of food to their taste. Here they gather, commence to feed and grow, although owing to their small size, the amount of damage which they do at this first stage is not so

very great. It is not usually till the second or third stage that they are *able* to eat cane or that they do so. I would emphasise this, as they do not enter cane till the third instar usually. After about ten days they shed their skins and increase in size to about half-an-inch in length, and again shed their skins four more times at intervals of about ten days when they become fully-grown. Their growth may be shown thus :—

Stage.	Length (inches).
1 (newly hatched) ...	$\frac{1}{4}$
2	$\frac{1}{2}$
3	$\frac{3}{4}$
4	1
5	$1\frac{1}{4}$
6 (winged stage) ...	$1\frac{3}{4}$

there being an interval of about ten days before the commencement of each succeeding stage. As the hoppers grow larger they require a larger quantity of vegetation to nourish them and the damage which they do consequently becomes greater. It must be noted that it is only in the final stage that the grasshoppers have wings, and it is in this last stage only that they are able to fly and to lay eggs and in this stage also they live longest (excluding the egg stage when they do no active damage) and do most harm. In this winged stage the grasshoppers are all alike in colour and appearance, but before they obtain wings they may be green, or yellow, or brown, although their usual colour is yellowish green. This is not the place to enter into a minute description of the insect in all its stages. You are probably all only too familiar with it, but specimens and coloured figures exhibited will show what it is like to any one who is not acquainted with its appearance.

The hoppers, after they have begun to grow a little, are very voracious and eat up all the leaf of a field in a short time, every part of the leaf except the midrib being devoured. By the time they are full-grown the great majority of them are to be found in the *Ukh* (sugar-cane) fields, this fact being probably due partly to their finding in these fields a large mass of vegetation suited to their taste and affording at the same time a certain

amount of protection against insect-eating birds, and partly to the fact that by this time most of the *kharif* crops have been harvested. They are only active in the day-time, apparently feeding at intervals throughout the day, but chiefly in the morning. By night they are sluggish and inactive and do not seem to feed.

About the end of the rains the grasshoppers pair, lay their eggs and die, but the period of adult life may be protracted until quite late in the year. At Azamgarh in 1908, egg-laying took place as early as the end of August, whilst at Pusa all the grasshoppers are usually dead by the middle of November, although during 1910 many were still alive in the middle of December. As a rule, however, egg-laying takes place in September or October. The eggs are not laid at random, but, on the contrary, the female exercises great care in choosing a suitable locality, carefully examining the ground and, if no suitable place is found, taking long jumps in search of another likely spot. Having finally satisfied herself of the eligibility of the site selected, the female raises herself on her legs and bends down her abdomen until its tip touches the ground and proceeds to bore a hole which goes straight down for about two inches into the soil. As soon as the hole is ready the female lays her eggs at the bottom of it, the eggs being laid in packets about $\frac{3}{4}$ inch in length and containing some 20—50 eggs. When first laid the egg-mass is covered with a gummy coating which is quite soft but soon hardens to form a protective covering to the eggs. About four lots of eggs are usually laid by each female, which then dies almost immediately afterwards. The hole in which the egg-mass has been laid is sometimes filled up with earth by the grasshopper, sometimes left open ; in any case, it is impracticable to find the egg-masses by mere inspection of the ground without actually digging it up.

Looking at the life-history of the grasshopper, we see that it divides up into two distinct periods, which are, roughly speaking :—

(1) Mid-June to Mid-October when the grasshoppers are actively employed in eating the crops.

(2) Mid-October to Mid-June when the eggs are lying dormant in the soil and no actual damage is being done.

During the first period, *i.e.*, during the rains, we can fight the grasshopper by dragging bags over the young crops and then killing the insects caught in this way. This method, however, is not within the reach of the small cultivator, simply because he is quite unable to meet the extra expense of even so simple a contrivance as a bag. There is, however, one method which he may adopt at this time of the year for what it is worth, and that is the encouragement of insect-eating birds by the erection of a few suitable resting places for them amongst the crops. In the Agricultural Court of this Exhibition is shown a collection of some of the commonest of the birds of India, and every one of these birds has been assessed at a certain value based solely on a careful consideration of the question as to whether or not it is of benefit to the cultivator. An inspection of these birds and of the specimens of insects (also exhibited) will show which birds are actually useful and therefore to be encouraged and even the most poverty-stricken cultivator can at least try to attract the birds to help him by putting up branches and so giving them perches to rest on.

But it is during the cold weather and in the hot weather before the rains begin that the grasshopper is most open to attack. During the whole of this period of seven or eight months the eggs are lying in the soil, only a couple of inches below the surface, unable to move, helpless and positively inviting us to assume the offensive and prevent their hatching and doing us any damage. The measures to be taken are quite simple and merely consist in ploughing up the soil about March and so exposing the egg-masses to the light and heat of the sun. The best thing to do is to plough up the land in those tracts where it can be ploughed with an iron plough immediately after the crop has been harvested in March and to plough it over again three weeks afterwards. If an iron plough cannot be used, a country plough will be better than nothing, but it must be borne in mind that the end to be accomplished is the thorough turning up of

the soil and the consequent exposure of the egg-masses to the sun. The old *ukh* roots must be dug up and burnt before the ploughing takes place. A large number of the egg-masses will be found under and amongst the roots and they will thus be exposed and killed and the burning of the roots and stubble will help to prevent the increase of other injurious insects which live there. There is one point about these egg-masses which deserves mention and it is this : it has been noticed that the grasshoppers attack one crop of cane or rice in a village after another and that they lay most of their eggs in the fields which they attack last. By noting the fields in which there were most grasshoppers about September and by making a few trial diggings in these fields in the winter, the fields which contain the majority of eggs can probably be ascertained and these fields especially dealt with by ploughing in March. The eggs are probably laid in whatever fields the grasshoppers are feeding in at the egg-laying period (about September), but in the case of crops of *sawan*, *mandua*, etc., the egg-masses are probably destroyed to a large extent by the disturbance of the soil consequent on the cultivation which follows in the succeeding *rabi*. The cane *peri*, however, is usually allowed to lie over and the eggs in these fields are consequently not disturbed until they hatch out. Once again therefore I would urge the importance of rooting up the old *ukh* stumps and of thoroughly ploughing up the *peri* immediately the cane has been harvested.

Other methods of less importance which are worth carrying out are the constant grazing of cattle especially on fallow lands in the vicinity of cane fields, and clean cultivation around the crops themselves (on field embankments, etc.).

The damage done by the grasshopper may also be lessened by growing Borakha *ukh* as far as possible. This variety is comparatively a much harder food, less attractive to the grasshopper than the *mungo* variety and grows up quicker. It is not, however, in favour with cultivators as the yield of sugar is considered to be less.

Finally, in considering the damage done by this pest and the best means of lessening it, there is one point that must be insisted upon, and that is *co-operation.* It is most important that a cultivator should have sufficient knowledge, sufficient forethought, and sufficient energy to do all that lies in his power to protect his own crops by destroying the eggs before they hatch and by using every endeavour to destroy and harry the hoppers after they have emerged from the egg, but this is not enough; he should use every endeavour to induce his neighbours to do the same; otherwise, the eggs will hatch out in *their* fields and after destroying *their* crops, will invade *his.* If all the cultivators will agree to join in and work together, a great deal can be done and all their crops will benefit; but if only a few fields are left untreated, the grasshoppers will hatch out there and spread out thence to infest the surrounding areas.

The Potato Moth.

The other insect pest to which I want to draw attention is the potato moth and the best means of storing seed-potatoes.

The potato moth, although well-known in America, Europe and Australia seems to be a fairly recent arrival in India. It has been suggested that it was first imported in seed-potatoes received from Italy, and this is possibly true; the fact, however, remains that the moth has now obtained a firm footing in India and is steadily spreading into every district where potatoes are grown. In some cases we can say definitely that the moth has now invaded localities which were free of infection a few years ago. Much of this infection of new areas is undoubtedly caused directly by the importation of infected potatoes from one district to another, and with the present large consumption of potatoes for food it is practically impossible to prevent the spread of the moth in this way.

The moth itself is a very small greyish-brown insect, which can be seen flying about the potato-fields or sitting on the stored potatoes. The caterpillar can feed on the leaves or shoots of the growing potato-plant or inside the potato itself. It is when it is

feeding in the potato that it does most damage and is most liable to be carried into fresh districts. A whole life-cycle of the pest, from egg to moth, may take as short a period as four or five weeks, and as each female moth may lay upwards of 100 eggs, the increase may be very rapid. Assuming each female to lay only half this number of eggs, then if the whole progeny of a single female survived, they would total very nearly twenty millions (two hundred lakhs) in the fifth generation, that is to say, after five or at the most six months. In actual practice, of course, the moths do not increase at this rate, but it will readily be seen that their rate of increase may be extremely rapid under favourable circumstances, so that a very small quantity of diseased potatoes introduced into a new locality will quickly infect the whole area. The pest being one that has been introduced into India, the conditions for its rapid increase are unfortunately only too favourable, as none of its natural enemies in the shape of parasites appear to have been introduced with it, so that the only real check on its increase is the quantity of food which is available. So far as we are aware at present the caterpillar feeds only on potato in India, although in other countries it has been found to feed on various species of *Solanum* and also on the tomato (*Lycopersicum esculentum*) and on the tobacco plant.

We cannot in practice prevent the caterpillar from feeding on the growing potato-plant: spraying would be useless, as the caterpillar is a miner inside the leaves and shoots. In these provinces, potato is grown in the cold weather when the pest is comparatively inactive so that damage to the growing plant is not important. But we can prevent it from mining our seed-potatoes which are being kept to sow for the next harvest. Experiments made at Pusa and carried out on a practical scale in the Central Provinces have shown that it is possible to keep potatoes free from the moth during the period between April, when the spring crop ripens, and September-October when the autumn crop is sown. Full details of these experiments will be found in the Agricultural Journal of India for January 1910.

Briefly speaking, the method aims firstly at killing any eggs which may have been laid on the potatoes; and secondly, at protecting the potatoes from any further attack by the moths. The potatoes are steeped for five minutes in a solution of Crude Oil Emulsion prepared by simply adding one pint (one and a quarter pounds) of Crude Oil Emulsion to four gallons (one kerosene oil tin full) of water and stirring the mixture with a stick. After steeping in this, the potatoes are taken out, dried, and stored under sand which must be quite dry but not hot. The oily mixture kills any eggs which may be on the potatoes and the covering of sand effectually prevents the moths from laying their eggs on them again. The potatoes must be examined about once every month whilst they are so stored and any which may have rotted, picked out and destroyed. The actual loss of seed-potatoes during the monsoon after treatment in this way is usually about one-third to one-half of the original weight. But it is to be noted that, before the potato moth was known at all in India, the loss of seed-potatoes during the monsoon was generally reckoned at about one-third, due to attacks of fungi, etc., during the damp weather, and to loss of weight by simple drying.

The method of treatment with Crude Oil Emulsion was devised especially for the treatment of potatoes reserved for seed for the next crop, and objection has been raised that the use of the crude oil imparts a disagreeable taste to potatoes intended for eating purposes. If this is found to be so, the use of the oil may be omitted, *but only in the case of potatoes not intended for seed.* When the potatoes are dug, the tubers are, or should be, free from the moth which up to then has been feeding on the parts of the plant above ground, and if the tubers are dug in dry weather (which is the case of those taken up in April and May) and *immediately* stored under dry sand, they should remain free from the moth.

As soon as the crop is dug, the tops of the plants should be collected and carefully *burnt* to destroy any moths which may be in them and great care must be taken, when rejecting diseased

and rotten potatoes from the store, that all such are carefully and thoroughly destroyed. If the potatoes in store are covered with sand so that the moths cannot get at them to lay eggs, and all other food in the shape of haulms and rejected potatoes is carefully destroyed, there is some hope that the pest may be starved out, or at least kept within reasonable bounds. The difficulty has been to find a method of storing which will prevent the moth getting at the tubers : if the tubers are kept in a closed box for instance they rot and only after trying 40 different ways it was found that storage in dry clean sand prevents the moth laying eggs and at the same time does not induce rot.

But, just as in the case of the cane grasshopper, one of the most important things is co-operation. If everyone works together, protects his crop from attack in the manner outlined above, and keeps his potato fields and his potato-store clean and free from stalks or rejected potatoes where the moth may be able to go on breeding, it may be possible to do a good deal against this pest and to keep it more or less under control, but a single neglected field or dirty store-house may prove a centre of infection or re-infection for the rest of the village or the surrounding neighbourhood.

The potato moth is not known in all districts, it has probably quite recently entered Lucknow with seed from Patna.

We would urge most strongly the very great importance of not getting seed-potatoes from any infected area : the whole of Bombay, the Central Provinces and Bengal is infected ; a great part of the United Provinces is apparently not, and the pest does not seem to have reached the hills, so that uninfected seed-potatoes can be obtained.

We have discussed here only two pests, one indigenous to the province, one quite lately spread. In so far as the staple crops are concerned, there are probably no other pests lately introduced whose spread can be stopped, but there are plenty which are indigenous and which cause loss. There is not time now to discuss these ; they are known by experience to all cultivators and we hope to be able to help to check them ; but

there is no reason why cultivators should not themselves take an interest in them and find methods of checking them; it is quite certain that they cannot in this country apply expensive and difficult methods such as spraying to all crops or to most of them, nor can any one devise a medicine or poison that will keep insects off or kill them. What they do must be simple and cheap; it must be based upon a knowledge of the insect and its habits, and of the local agricultural practice. In these provinces there is a high standard of agriculture, but while great attention is paid to cattle, to seed and to ploughs, none is paid to insect pests. It is quite easy for cultivators to understand how their insect pests live, and if they knew that, they would be far better able to devise remedies for them than we can. They probably think this is a very difficult matter, and that only by deep study can they know how insects live and breed; but I assure them that it is a simple matter to understand once it has been studied: we do not expect them to study it; we do that; but just as we have explained quite simply above how two of their pests live so they can know quite simply about others. We would urge them to take an interest in this subject, and we have tried and are trying to spread knowledge of insect pests and their habits. In the Exhibition are shown the chief pests of the province; books, leaflets and articles have been and are being published, cultivators can get full information about pests: if we cannot in all cases give them direct remedies it is because we cannot from a distance understand the agricultural conditions of all districts and this is as important as knowing how the pests live and breed. There are probably very few cultivators who know even that a moth lays eggs, which become caterpillars, which then enter a resting stage before they come out as moths. If all agricultural people knew even that, we should be a very long way towards getting an interest taken in pests and in methods of checking them. If they want to get help in checking their pests, the borer in the *juari* (*Andropogon Sorghum*) and cane, the boll-worm in the cotton, the aphis (*tela*) in the mustard, the leaf hoppers in the mango blossom, the white bug on the mango shoots, etc., they must realise that it

is essential that they and all agricultural people should know something of them and their habits, and landowners as the leaders of the community should stimulate this and give us, who are trying to help, the assistance and co-operation that are absolutely essential.

CAMBODIA COTTON IN INDIA.

By P. VENKAYYA,

Superintendent of Farms, Munagala Estate, Jalalpet.

(Reproduced from the "*Indian Textile Journal*" *of* 10*th June* 1910.)

The Honourable Sir V. D. Thackersey, as President of the second Industrial Conference at Calcutta, remarked: that "the reason why the Indian millowners have to restrict themselves for the production of coarser sorts of cloth is the quality of cotton grown in the country at present. So long as cotton of superior staple is not produced here, it is hopeless to expect the manufacturer to improve the quality of his cloth. . . . . . . If the country gives the Indian manufacturer a superior staple cotton, there can hardly be a doubt that he will be able to supply the needs of the people from his looms. . . . Then will be the time for the full realisation of the *swadeshi* ideal in respect of our clothing. Until then for superior varieties of cloth we must depend on the foreign producer."

It is to solve this problem of "finding out" a long-stapled cotton which may be universally grown in place of the inferior varieties of short-stapled cottons which are now raised all over the country that an experimental cotton farm was started by the zemindar of Munagala in Kistna District (Madras), which is working for the last two years. About eleven varieties of cottons have been tried, six of them being among the most important cottons of the world. They are the famous Sea-Island cotton of the United States which stands to-day unequalled on the cotton market, the Egyptian cotton which is supposed to have been originally the same as the Sea-Island but altered by cultivation

PLATE XXIV.

A. J. I.

FRONT VIEW OF CASE PREPARED FOR EXHIBITION. PACKING MATERIALS GO OUT OF SIGHT BEHIND FALSE PANEL UNDER DRAWERS IN MIDDLE UNITS.

and climatic conditions in Egypt, the "Caravonica" cotton invented by Dr. Thomatis of Queensland in Australia who produced it by crossing the Sea-Island and Pernambuco cottons, the "Spence tree cotton" about whose excellence many columns appeared in the journals of Western and Northern India, the "kidney cotton" which is specially valued for its rough stapled lint, and the "Cambodia" cotton, a native of the Indo-Chinese Peninsula, which is a hardy and long-stapled annual, yielding lint of a superior white colour. Out of these, the Sea-Island and Caravonica cottons being plants which require the influence of the sea to a great extent did not give any satisfactory results. The Egyptian cotton which requires a very high standard of cultivation and copious irrigation, both of which are a little above the means of the ordinary cultivator of this Presidency, did not also take kindly to our farm soils. The "kidney cotton" became very herbaceous and yielded little in the first year, whereas the Cambodia cotton gave very excellent results. The following report on Cambodia cotton from the Bombay Chamber of Commerce, which is perhaps the highest authority on cotton questions in India, will clearly show that this hardy long-stapled cotton possibly would ultimately revolutionise the cotton cultivation of India :—

Bombay, 11*th May* 1908.

"I am directed to acknowledge receipt of your two letters together with a sample of Cambodia cotton and in reply to forward you the following report on the latter :—The sample is 'kapas,' *i.e.*, the seeds have not been extracted. In order to make the cotton marketable it will be necessary to gin it. The cotton is very white, long stapled, about 1⅓ inches staple, with fine strong fibre. *It is the best cotton the reporter has ever seen grown in India except tree cotton.* Its value to-day, properly ginned and packed in bales, would be about Rs. 270 per candy, Broach being only Rs. 225. It can be used up to 32's warp and 50's weft. At the above-mentioned price all the cotton that can be possibly produced could be disposed of with ease, if properly ginned and delivered free of charge at the Wari-Bunder Railway Station. ......

(Sd.) J. B. LESLIE ROGERS,
Secretary."

Again, the famous firm of Messrs Tata Sons & Co., of Bombay, in a letter, dated 19th March, 1908, says :— " . . . The colour of this cotton is very good being purely white. The staple is long and tolerably strong. We value it to-day at about Rs. 270 per candy.

Yours faithfully,

(Sd.) TATA SONS & CO."

The Deputy Director of Agriculture, Northern Division, who was deputed by the Director of Agriculture, Madras, to inspect our Cambodia cotton and furnish a report on it made the following remarks in his report :—

"The introduction of Cambodia cotton into the Munagala Zemindari appears to have every chance of success. . . . Of these No. 1 Cambodia was growing well. The prospects of Cambodia are promising. . . . . . ."

I.—CLAIMS OF THE CAMBODIA COTTON.

Now, the superiority of Cambodia cotton over all the Indian grown cottons and the advisability of replacing them as far as possible by Cambodia cotton can thus be clearly understood by a reference to the above letters. It should be borne in mind that the price of a candy of Cambodia cotton is Rs. 270 and an acre of land produces one candy of cotton on an average. The cotton is dead white in colour, the staple is fine, silky and $1\frac{1}{8}$ inches long. What can the apathetic *rayat* desire more ? Nature would seem clearly to have devised this tree to meet the present crying need for long-stapled cotton in India. The quality of this cotton is so excellent that it opens an entirely new field for Indian manufacturers, the importance of which, bearing greatly as it does upon the future prosperity of the country, cannot be overestimated. The great advantage and importance of Cambodia cotton is that it is practically a hardy annual, but not a perennial,—for perennials are always greatly subject to insect pests—that it is sown exactly at the same time when all the country cottons are sown, and also ripens just within the same period like the rest of the Indian cottons, that it requires no irrigation, and the

treatment it requires is also just the same as that given to any other cotton at present cultivated in the country, that it will also grow and flourish practically in any soil in this country on which the ordinary country cottons will grow and flourish, and that it also fetches a fairly higher price to the impoverished *rayat* than any other country cotton. At the same time it also solves the problem of long-stapled cotton for the manufacturer. These are the claims of Cambodia cotton over the Indian cottons.

Now, for the information of agriculturists who wish to introduce Cambodia cotton into their lands, I wish to state that seed sufficient for one acre will be supplied on payment of Rs. 5. No order for below one acre of land will be complied with. One *viss* of seed is generally sufficient for one acre, and this is the minimum quantity supplied. Orders for less than one *viss* cannot be attended to. Intending purchasers should apply to me at Jalalpet, Masulipatam. Applications should be made before the 15th of August every year. The sowing season commences after the 15th of August every year.

II.—A Brief Account of this Cotton and the Method of its Cultivation.

Cambodia cotton is a native of the Indo-Chinese Peninsula. Black cotton soils and sandy loams are the best soils for the propagation of this annual cotton, that is, it grows readily on the soils that are generally allotted for the cultivation of the local cottons. As soon as the rains set in, the ground should be thoroughly ploughed four or five times and lines formed two and a half feet apart. In these lines or furrows the seeds should be sown two feet apart when there is sufficient moisture in the soil for the seed to germinate. The seeds should be rubbed thoroughly in cow-dung and earth prior to sowing. This not only keeps the seeds free from lint and other material to facilitate sowing, but also helps germination to some extent. As soon as the germination is complete the field should be gone through and any blank spots resown. The after-treatment which the ordinary

short-stapled cottons receive at the hands of the local *rayat* is also enough for this exotic plant.

III.—Time of Sowing.

The middle of August is generally the best time for sowing. The plants begin to flower in their third month, but bearing does not take place till the beginning of the fifth month. The plants go on bearing for three months continuously. The cotton collected from the first picking is generally considered to be very good. So, care should be taken not to mix it with the cotton collected during the latter pickings. The cotton from the second picking is not so bright as the first, and it should, therefore, be kept separate. If, by mistake, all the pickings are mixed together, the buyer will only offer the price of the lowest grade. It may sometimes so happen that two or more varieties of cotton may be standing side by side in a field. In this case care must be taken not to mix one with the other during the picking season.

IV.—Irrigation.

Like all the local short-stapled cottons, this variety needs no special irrigation. On the other hand, it must be distinctly remembered that a thorough drainage is quite necessary for this or any other variety of cotton plant. If water remains stagnant at the roots of the plants, danger is imminent.

V.—Time and Method of Picking.

As soon as the capsules are well open all over the field picking should at once commence before the cotton begins to fall on the ground. The best time to commence picking is generally in the morning. The picker should hold the boll firmly with the left hand and remove the seed-cotton with one pull by the right. If he takes two pulls he will only get half the amount picked per day. Cotton should always be picked when the boll is fully opened. If it is picked before the boll is quite ripe the cotton is brittle and does not fetch a good price. The most important point, however, in picking cotton is to see that in

extracting the "seed-cotton" from the boll nothing like bits of dry leaves, trash, etc., should adhere to it. If anything should get attached, it must be picked off at once. The reason is, if the cotton to which the trash is attached is put into the bag with other cotton, the trash becomes pressed into the lint and it is very difficult to remove it afterwards, the labourers often breaking the fibre in removing it. Care should also be taken not to mix discoloured or unripe cotton with the good produce. One of the chief reasons for the low prices paid to the Indian cottons in the foreign markets is careless picking. Leaving cotton in the field after it is ripe also causes it to deteriorate. Cotton left exposed to the weather becomes stained and loses its strength rapidly; consequently cotton so treated must prove of poor quality.

VI.—Cleaning and Drying.

As soon as the cotton is picked it should be sunned until it is thoroughly dry. While it is being sunned, stained cotton or immature bolls should be removed, and at the same time any cotton that has fallen to the ground and got earth and sand mixed up with it should be "whipped" so as to have it perfectly clean before it is sold or sent to the gin.

VII.—The Importance and Necessity of Seed Selection.

It is absolutely necessary to select good seed. A good crop cannot be obtained from a doubtful stock nor can good stapled cotton be produced from an inferior variety of seed. In the Western countries there are large numbers of trustworthy seed merchants whose existence depends upon being able to supply choice seeds of every kind of crop. In this country seedsmen in the ordinary way are non-existent, so that each cultivator is thrown more or less on his own resources for the supply of seed for the various crops. Cotton is the crop in which we are at present most interested, but the methods to be described are applicable to every crop under cultivation. For the production of high quality and big yields, failure can be the only

result if the best seed be not sown, no matter how good the cultivation or liberal the manuring. In the selection of seed for cotton we have two primary objects in view, *viz.*, to obtain the greatest yield and the best quality. To select for both objects at the same time is quite possible, though we think that the main object in view can be accomplished by growing in the first place the very best seed obtainable and then selecting seed from the heaviest yielding plants, provided the quality of those plants is equal to the best standard of that variety. In the system of selection adopted by the Sea-Island planters in America most distinctive results have been obtained. For example, one grower's ideal has been to obtain heavy yields with but a secondary regard for quality, and this has been quite successful, the grower's cotton being known in the market as that from heavy yielding plants, but whose quality is not "extra." Another planter again has selected for quality only, and though yield has been to a certain extent sacrificed, yet his cotton is sold for a much higher price. Thus starting with the same seed, two different ideals may be reached according to the wish of the particular grower. As a rule, however, our primary object is to increase the yield, and while striving to obtain this we have to see that we do not sacrifice quality and other desirable characteristics, but keep them at least up to the best standard. An area of the variety chosen should be planted with the best seed obtainable, and should possess a good soil and be thoroughly cultivated and manured in order to obtain a good development of the plants, and consequently ideal conditions for making selection. Just before the first picking, when some of the lower bolls are well open on all of the plants, the field should be gone over and every plant examined with reference to productiveness, number and size of the bolls, vigour and shape of the plant, early ripening, etc.

Ample proof has been given over and over again that in any particular district seed can be produced by selection, which, for vitality, immunity from disease and crop producing qualities far excels that of any variety suddenly dumped down from outside sources. Below are some of the methods generally adopted for

improving cotton, many of which can be easily carried out by even the uneducated *rayat* :—

Reserve the best part of the crop for seed. This can be generally done by reserving a certain area for seed purposes and giving it full opportunities for good development and the resulting crop is kept back entirely for the next season's sowing. Another method, no less commendable, is to go over the growing crop and note any particular areas of great promise. The seed from the selected portions is carefully set apart for next year's crop; but neither of the above is sufficient if we wish to progress on the right lines. For example, if we wish to develop a variety of cotton which above all its other qualities, must be an early ripener, what system should we adopt to attain that end? We must collect the early ripening bolls, and after ginning this cotton by itself reserve the seed for propagation of the crop. That this is sound and efficacious has been demonstrated times without number. Perhaps the best object lesson in this respect is to be found in a careful study of Sea-Island cotton which today stands pre-eminent. Long ago when cotton seed was first introduced into that district in America, it failed to give a crop in the first season. The plants died down, but, in the spring of the next year, grew up and managed to ripen a few bolls before the end of the second season. The seeds from these were again planted with great care. The method was assiduously followed up until to-day we find the Sea-Island cotton ripening its crop in one season. And not only so, but, in the meantime the length, strength and fineness of the product have been enormously improved, so that nowadays it is unequalled in the market.

Another important point to be remembered in the selection of seed is the keeping back for seed purposes of the biggest and best developed seeds from the whole crop. It to some extent ensures that the seed contains a supply of nourishment sufficient to give the young plant a good start in life and to tide it over any early struggles for existence.

Spontaneous types or sports frequently occur in plant-life. These differ greatly from the surrounding plants and if the quali-

ties of the product are in any way superior the type should be propagated and tended until it becomes fixed. Sports result chiefly from natural crossing in the field or from the influence of the soil, climate and cultivation on that particular plant. In one of the villages of this Zemindari I have come across a kidney cotton tree, the seed of which, much unlike the seed of its family, is green like a leaf. We have preserved the seed of this plant and the matter is under investigation.

A still more comparatively simple method of selection which could be undertaken by every one is as follows :—

Select the best looking plants for seed purposes.

Reserve only the best developed seed.

Select the earliest ripening bolls for seed.

Select the plants which flower at first.

Select the plant which bears very heavily.

Select the plant which yields the biggest bolls.

Select the plant which gives a very white lint and a long staple, combined with a smooth and silky texture, and a uniform fibre which will withstand a fair strain in testing its strength.

It is desirable to mark more plants than are expected to be used, because in going over and comparing the plants the first time, it is ordinarily found difficult to carry the characters desired in mind with sufficient accuracy to enable a careful judgment to be made. Therefore some fifty of the plants should be first marked and numbered, so that these can be more carefully examined a second time and the number reduced probably by one-half or more. The permanent numbers should be placed only on the plants which are finally selected. Before each picking an intelligent man should go over the field and pick the cotton from each plant in sacks numbered to correspond with the numbers on the plants in order that the different pickings from the same plant may be kept together. Later on, after the close of the picking season, the seed-cotton from each individual plant can be more carefully compared and weighed and any of the plants which are found to have fallen below the standard of production, or in any other important feature, should be rejected. The remainder

should be ginned, care being taken to have the gin thoroughly cleaned out before beginning the process, so that the seed from the selections will not become mixed with ordinary seed. After ginning each individual plant, the seed should be carefully picked up and replaced in the numbered sack, so that all of the seed from the same select individual will be retained by itself. In this connection I think it will not be out of place to say something about the mixing of seed in general. Mixing of seed can easily take place either at the gins, or in the riddles where the seed is separated if required for sowing purposes, the small and broken seed being rejected. Thus, after one variety of cotton has been through the machinery, unless great care is taken to clean up all the seed, mixing follows when the next kind is being dealt with. Such is the case in all large ginning factories where different varieties of cotton are dealt with. So the practice of purchasing seed for seed purposes from the ginning factories must be discouraged as far as possible. The ideal condition for each cultivator is to hand-gin his own seed for seed purposes.

These few instructions will, I hope, help those who wish to undertake the cultivation of this cotton. I will be only too glad to furnish any further information required in connection with the cultivation of Cambodia cotton. I have already pointed out that my wish is to disseminate knowledge of this cotton as far as possible in order to secure the cultivation of this long-stapled cotton all over the country.

NOTES.

Paddy Seedlings Experiment.—An interesting experiment has been conducted by Mr. E. S. Baldwin, Deputy Magistrate, Darbhanga, to test the possibility of transport of paddy seedlings for considerable distance by cart and rail in time of famine. In conducting the experiment the seedlings were plucked from the nursery, then kept one day in a cart in the open, three days in a railway truck closed, and once again for a day in a cart. The conclusion arrived at by Mr. Baldwin was, that with proper treatment about 7/8ths of the seedlings will survive and be fit for transplanting at the end of the period mentioned above. The conditions under which transport should take place are given by the experimenter as follows :—

"It is necessary that the day previous to the loading in the railway trucks, the paddy seedlings should be freshly plucked, tied into small bundles (*antis*), and then loaded on to carts after being freely sprinkled over with water. The watering should be carefully supervised, as natives are fond of washing the roots and thus removing the soil attached thereto. This should not be allowed. The seedlings will last longer if the soil is allowed to remain.

"On loading into the railway trucks the seedlings should once more be watered, but not to excess, as one result of the experiment has been to show that if too much water is poured over them, they are liable to wither away, owing to the heat given out by the seedlings themselves, combined with the heated and rarefied air inside the truck. The best method in order to safeguard the seedlings from being watered to excess, would be to employ gardening water cans fitted with the sprinklers, if handy. This method would save time and trouble.

"The experiment has further shown that a great deal depends on the manner in which the seedlings are loaded into the railway vans. It was found that those seedlings, which had been loaded standing upright (roots downwards), one above another, in two, and even three layers, were in a far fresher condition, and lasted longer than those seedlings loaded lengthwise on the floor, one above another. If loaded in the former manner, *i.e.*, standing upright, the seedlings will be in quite good condition and fit for planting on the fifth day after the plucking of same, and may possibly last to the sixth day, though the earlier the better.

"The simplest method of packing the seedlings standing upright in the trucks, would be to make one big bundle of 12 to 15 small bundles (*antis*) tied together, though, in order to ensure their keeping good, the small bundles must on no account be tied together tightly, but may with great advantage be given what is generally termed 'breathing space.' The big bundles should be tied with stems and not with ropes if possible.

"On the seedlings being taken out of the railway truck for despatch to the necessary centres, they should once more be subjected to a watering, and then placed on the carts."

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Note on an Exhibition Case :—The following note gives a brief description of a portable Exhibition show case which was designed specially for the use of the Department in sending exhibits to agricultural and cattle shows. It is proposed to keep at head-quarters ready prepared classes of exhibits suitable to the district in which the exhibition is to be held, so that the case may be prepared with the least trouble and at the shortest notice. It is hoped that the ideas embodied therein may be useful to other departments.

The idea throughout has been to make the case attractive in appearance, light, rigid, and at the same time easily put together. It is made throughout of deal, polished black and picked out with gold. The one illustrated was made in Madras by a local

carpenter and cost Rs. 200 complete but without the tin cases. These are enamelled green and were also made in Madras at a cost of Rs. 1-8-0 a-piece. The total cost has thus come to less than Rs. 300.

From the plans, the construction will be easily made out: of the three units, the centre one and the right hand one fold together, while the left hand one which is attached by thumb screws, packs above them, the whole being then fitted into a crate. The projecting portion of the central unit consisting of a sloping glass desk with drawers beneath, rests on two opened panels, the space beneath being filled in with a false panel. The shelves are throughout adjustable, except those in the lower half of the side units which fold flat when not in use. The projecting frames are hinged on to two slats which are screwed to the side of the case: they pack separately and can be used or not as desired.

The tin cases open at the top, and can be made to hold samples of grain, cotton, fibre, manures, soils or anything else it may be desired to exhibit. Diagrams, maps, or plates, *e.g.*, of insect pests can be conveniently fastened to the side frames. The glass desk in front contains a tray which can be lifted out and could easily be fitted to show living silk-worms, or specimens of particular products or manures to which it is desired to give greater prominence. On the flaps of the side units will be found room for bulletins, pamphlets, calendars and other printed matter. (R. Cecil Wood.)

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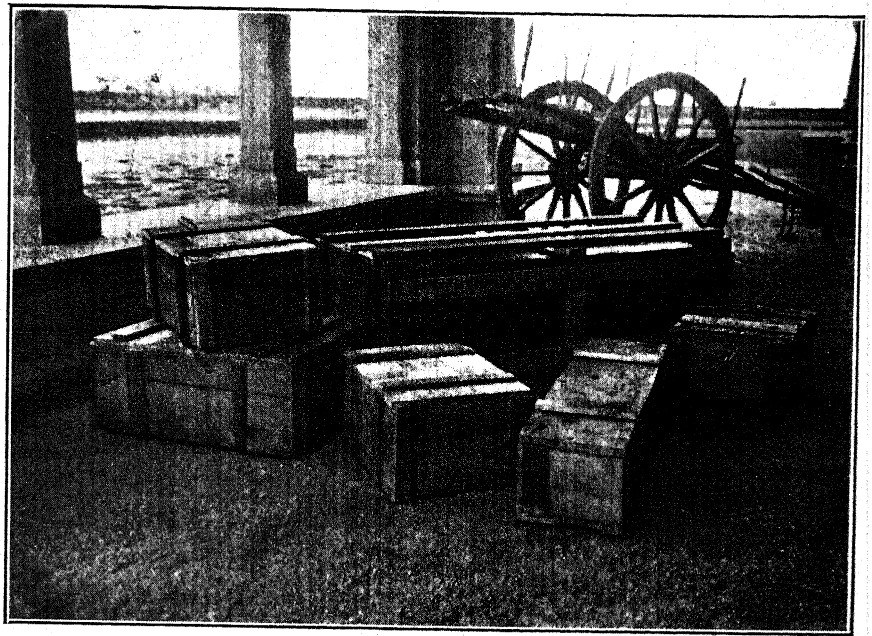
The Bambarra Groundnut.—The Bambarra groundnut (*Voandzeia subterranea*) is cultivated throughout Tropical Africa from the Sahara to Natal. It is a leguminous plant, in habit somewhat similar to the ordinary groundnut (*Arachis hypogæa*) but differing from it in that it has a lesser development of leaf system, and in that it forms its fruits around the principal stem and at a very small depth in the soil. This last characteristic of the Bambarra nut gives it a superiority over ordinary groundnut in so far as the harvesting of the former is much more easily

PLATE XXV.



CABINET PACKED READY FOR TRANSIT. THE LARGE CRATE CONTAINS THE THREE EMPTY UNITS. IN THE OTHER BOXES ARE PACKED THE TIN CASES AND THE OTHER FITTING.

A. J. I. THE CASE LOADED ON CARTS.

done than that of the latter. To harvest the crop, the stems are pulled up when nearly all the nuts adhere to them. The fruit is very like that of the ordinary groundnut, but is shorter, contains only one seed at maturity and possesses a prominent ridge which is absent in the fruit of *Arachis hypogæa.*

In Bulletin No. 21 of the Station Agronomique, Mauritius, it is stated that the requirements of the crop are the same as those of the ordinary groundnut. It is planted and harvested at the same time and in Mauritius is found to be a useful crop for cultivation between the rows of sugarcane. When so cultivated, it is sown in small pockets between the rows at distance of about 18″ apart both ways, three or four seeds being put into each pocket at a depth of about 1 inch.

The nuts are collected when the leaves begin to dry up. The yield is said to be at least equal to, and generally greater than, that of ordinary groundnut. Cultivated in the above way between rows of sugarcane, a yield of 960 kilos. of green nuts and 1,120 kilos. of green leaves have been obtained per *arpent* (1·043 acres). The green nuts usually lose about 50 per cent. of their weight on drying.

The composition of the dried nuts, as determined at the *Station* Agronomique, Mauritius, is shown in the following table:—

	Green.			Ripe.		
	Nuts.	Shells.	Entire fruits.	Nuts.	Shells.	Entire fruits.
Water	45·40	17·96	63·36	10·27	2·00	12·27
Ash	1·28	0·18	1·46	3·23	0·71	3·94
Cellulose	2·35	1·23	3·58	4·63	5·23	9·86
Fats	2·41	0·02	2·43	5·03	0·14	5·17
Sugar & Starch	20·49	2·66	23·15	46·80	8·60	55·40
Albuminoids	5·67	0·35	6·02	12·04	1·32	13·36

With respect to the relative demands on the plant food of the soil, it has been ascertained that the Bambarra nut requires a little less phosphoric acid, but much more potash than ordinary groundnut. Its nitrogen content, however, is always less.

The nut constitutes a complete food in itself. It may be used either for human consumption or for stock, while the leaves are useful either as fodder or green manure. When the ripe seed is ground, it is said to produce a very white meal from which excellent broths and soups may be made.

The main advantage of this plant over *Arachis hypogæa* seems to be that it can be harvested with much less trouble and at considerably less expense. As the cost of harvesting ground-nut is proving an obstacle to its cultivation in parts of India where the labour rate is high, the possibilities of the Bambarra nut seem worth while experimenting with in such parts.—(A. McKerral.)

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Indian Textile Fibres.—The *Indian Textile Journal* for November, 1910, contains two interesting notes on Indian Sunn hemp and *Calotropis gigantea* which may prove of some importance to those interested in the Indian fibre industry.

(1) *Sunn Hemp.*—Ten samples of Indian "Sunn" or "San" hemp (*Crotalaria juncea*) were examined recently by the Imperial Institute, London. They had been grown in the Pabna District of Eastern Bengal and Assam. An account of the cultivation and preparation of Sunn hemp in that District is given in the *Agricultural Ledger*, No. 7 of 1908-09, which includes the results of the present investigation. The area devoted to this crop in the Pabna District is almost entirely situated in the Serajganj sub-division and the total annual production of the fibre is estimated to be about 5,000 tons. The ten samples of fibre received at the Imperial Institute were regarded by commercial experts as worth from £18 to £25 per ton. The experts to whom the samples were submitted confirmed the conclusions, deduced from the results of the chemical examination, that these fibres were of remarkably good quality. They were also particularly satisfactory in respect of length, strength and colour, and would find a ready market. Several of them were above the average length and were very well prepared. It

may be of interest to compare the results of the chemical examination in the present instance with the figures obtained for specimens of Burmese and Calcutta Sunn hemp previously examined at the Imperial Institute :—

	No. 3 from Talgachi.	No. 2 from Ullapara.	No. 1 from Kaijuri.	Burmese Sunn Hemp.	Calcutta Sunn Hemp.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Moisture	8·0	8·3	8·2	9·8	·4
Ash	0·3	0·3	0·3	3·1	0·6
a. Hydrolysis (loss)	7·5	6·3	6·7	9·2	10·5
b. Ditto ditto	16·0	15·7	15·7	15·8	14·0
Acid purification (loss)... ...	1·0	1·0	1·4	3·7	1·6
Cellulose	87·9	88·8	87·6	87·5	90·8

This comparison indicates that the three samples from Eastern Bengal and Assam were of very good quality, and closely resembled those received from Burma and Calcutta. The results of this investigation show that the Sunn hemp of the Pabna District is of a quality which would find a ready sale at good prices in the United Kingdom. The cultivation of this crop, say the authorities of the Imperial Institute, can therefore be safely extended.

(2) *Calotropis Gigantea* is a shrub that grows all over India and is found at heights up to 3,000 feet. Its olive green velvety leaves and lavender coloured blossom are familiar in the jungles, and occasionally in gardens, and the silky white fibre that fills its seed pods has been the subject of many an unsuccessful attempt at spinning. In times of unusual drought, when half of the jungle trees seem to be dead, the *Calotropis* seems quite unaffected, showing it to be an exceedingly hardy plant. Like the rhea plant it possesses a valuable fibre that lies between the woody stem and the bark. This fibre is utilised by villagers for the manufacture of very strong ropes, and by fishermen on the Indus for their lines and nets; but the work of extraction is laborious and slow on account of the branching character of the plant, which seems to have an isolated habit. This is probably the reason why no machine has been found to be capable of extracting the fibre. *Calotropis* or *Akh*, to use the vernacular

name, does not appear to have been cultivated anywhere for its fibre, but a recent experiment of Monsieur Faure, whose name is permanently associated with the utilisation of ramie, seems to open up a good prospect for *Calotropis*. M. Faure, whose decorticating machine is still the best in the market, has made a long study of the cultivation of ramie, both in France and among the planters in India. In the latter country, it is planted like tea in spaces 4 by 4 feet apart with ample room for lateral growth, and the production of branches. M. Faure, on the contrary, has planted his cuttings at 13 inches distance, so that one acre contains 3,600 roots. From a plot of half an acre at Limoges he obtains regularly each year one ton of dry fibre in two crops. This represents two tons per acre, or four times what is obtained by planters in India. M. Faure's machine is best suited to deal with straight stems and his system of close planting produces just such stems as he requires, in great profusion, and the loss of fibre during treatment is reduced to a minimum. It is, therefore, probable that if the *Calotropis* were planted as closely, the growth of lateral branches would be suppressed and long straight stems would take their place. Even without the aid of any machine, straight stems, if they could be produced by close planting, might so facilitate the decortication by hand labour as to show a profit to the ryot. An experiment may be so easily made that a small plot might settle in one season the question whether the *Akh* is subject to the same influences as ramie. (*Indian Textile Journal*, November 1910.)

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SILK-WORM REARING IN THE PUNJAB.—The Punjab Department of Agriculture's Bulletin, No. 3 of 1910, consists of a series of interesting notes on the methods of silk-worm rearing adopted in the Province. The notes have been written almost entirely from materials collected by Mr. Milne, Economic Botanist, Punjab, and are based on M. L'Arbousset's book on "Silk and the Silk-worm" and on experience gained during two years' rearing at Lyallpur and Gurdaspur. As these notes have

special reference to local conditions, they ought to fulfil the object for which they have been published, *viz.*, to afford useful guidance to officers whose duty it is to control sericultural operations.

Part I of the Bulletin gives much useful information on the cultivation and care of mulberry trees. It points out that all the local varieties of mulberry are suitable for rearing silk-worms in the Punjab and that the Philippine mulberry (*Morus multicaulis*) is specially useful for producing leaf early in the season. It has been found that the mulberry can be propagated either from seed, from layerings or from cuttings, and instructions are given for propagation in each of these ways. Layering, however, has been found troublesome, and on the whole propagation by cuttings seems to be the simplest and most efficacious method. A useful section is that dealing with the pruning of mulberry trees, and that on the rejuvenation of old trees. Special emphasis is laid on the facts that pruning should be done with a sharp knife, rather than with scissors, and that large wounds should be coated with tar to prevent disease germs entering.

Part II deals with the care of silk-worms. It points out that the first essential to success is to secure eggs free from disease and notes that previous failures in silk-rearing in the Punjab and Kashmir were largely due to the use of diseased eggs. Reliable French eggs can now be obtained from the Director of Agriculture, Punjab, if notice is given before May 15th, the eggs costing about Rs. 2-8-0 per ounce. It is pointed out that one ounce of eggs requires about 25 well-grown mulberry trees and that one ounce of eggs is the quantity that can be conveniently managed by one family. Imported French eggs have to arrive in India early in October, and it has been found from experience in the Punjab that they must, on arrival, be kept in cold storage or sent to the hills. The temperature of storage must not rise above 50° F., and if they are kept at this temperature for 15 days incubation starts, and, when once started, cannot be stopped. This part of the Bulletin lays special

emphasis on the necessity for having temperatures accurately recorded, on having the incubating room thoroughly disinfected, and on the necessity of starting incubation at the proper time. To start incubation the temperature of the room should be raised to 60° F., as soon as the mulberry trees begin to show buds. This is about February 12th in the Central Punjab. When incubation has started, the temperature should then be increased one degree each day until it is above 77°. The worms will hatch out in about 14 days from the starting of incubation and the temperature of 77° is a suitable one to maintain them at until the first moult. After this, 74° F. is required and anything above 80° F. has been found to be injurious. The Bulletin recommends that if sericulture is established in the Punjab, a cheap and simple French incubator—the "castelet," will be found very convenient.

Important instructions are given on the space which should be allowed for the worms from one ounce of eggs. The following table gives the results of experience on this point :—

Birth to first moult	50	sq. ft.
First to second moult	40	"
Third to fourth moult	120	"
Fourth to rising	300 to 500	"

Emphasis is laid on the fact that native rearers invariably overcrowd their worms.

The quality and quantity of food given to silk-worms at their various stages has an important effect on the quantity and quality of the silk produced and the Bulletin points out that a common fault among native rearers is an insufficient supply of food to meet the voracious appetite which the worms develop after the fourth moult and before rising. Attention is drawn to the fact that sudden changes in the food supply ought to be avoided, while dusty, wet, fermented, or dried up leaves, should never be supplied. Fermented leaves are held to be the cause of the disease known as "flacherie." It is recommended that worms should be fed five times a day at about intervals of four hours each.

A description is given of the various kinds of faulty cocoons, with the causes of their production and an account is given of the commoner diseases of the silk-worm with symptoms and known remedies or means of prevention.

That the outturn of silk can be much increased by careful attention to the points on which the Bulletin lays emphasis is demonstrated by the results of experiments conducted at Gurdaspur, Changa Manga, and Lyallpur in 1909, quoted in the last paragraph of the Bulletin and given below :—

Name of place.	Ounces of seed.		Weight of				
	Issued.	Hatched.	Green cocoons.	Dried cocoons.	Silk.	Chassam.	Silk per ounce of eggs hatched.
			M. S.	M. S.	S. C.	S. C.	S. C.
Gurdaspur ...	23	18½	...	4 1	31 13	15 2	1 14
Changa Manga ...	2	2	2 36	0 29	7 2	1 15	3 9
Lyallpur ...	1	1	1 8¼	0 15¼	3 2	1 1½	3 2

The fact that the weight of silk per ounce hatched was much higher at Lyallpur and Changa Manga than at Gurdaspur is due to the worms at the latter place having been entirely in the hands of native rearers using faulty methods, whereas at the two former places they received careful treatment in accordance with the principles laid down in the Bulletin.—(A. McKerral.)

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A Feeding Meal from the Scum obtained in Gul Boiling.—In a recent leaflet issued by the Bombay Department of Agriculture, attention is drawn to the fact that in the process of *gul* boiling, as practised in the indigenous way, considerable loss results from inability to utilize the scum which forms on the surface of the pan. The scum amounts to about forty pounds for every one thousand lbs. of juice handled and the Department, in a former leaflet, showed that half of this loss might be saved by the use of a scum strainer. The present leaflet describes a process whereby the remaining twenty pounds, instead of being thrown away as it is at present, may be converted into a valuable

cattle food. The process, together with information on the proper methods of feeding cattle with the product, is given as follows :—

Mix an equal quantity of water with the strained scum, and bring the resulting liquid to the boil in a *gul* pan. Any old rejected pan will do for the purpose. As soon as it boils, fine powdery *megass* should be mixed with it in the proportion of one part of *megass* to four of the original scum. The fire is then immediately stopped, and the whole mass is stirred until it is fairly cool. Then it is spread out on hard ground in the sun until thoroughly dry.

The fodder produced in this way is a very rich food, easily digested. It can be fed to cattle, at the rate of eight pounds per head per day—four pounds in the morning and four pounds in the evening. The *scum-meal* so prepared from the refuse of one *gul* boiling furnace is quite enough for all the bullocks required to work the mill supplying that furnace, and for them will entirely replace the safflower or other cake now given. Where *gul* making is carried on on a larger scale with a power-mill, it has been calculated that the cost of the *scum-meal* is about twelve annas per one thousand pounds of the product. It can then be fed to farm cattle or can be sold. Even if its price, for sale, be taken at so low a figure as one hundred pounds per rupee, it means a return of Rs. 10 per acre, costing about twelve annas only to make.

There is no difficulty in feeding it to cattle, provided the meal is quite dry. It should not, however, be left over till the monsoon, as it then becomes moist, and the cattle do not eat it readily. It should not be fed to cattle in larger quantities than four to five pounds per head at one time.—(A. McKERRAL.)

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SUGAR INDUSTRY IN THE ISLAND OF NEGROS.—We have received a copy of Mr. H. S. Walker's account of the sugar industry in the Island of Negros.

Negros is one of the smaller of the Philippine group and has an area of some 2,000 sq. miles and produces some 100,000

tons of sugar annually, which is nearly all exported. It is thus among the smallest of the producing centres.

The cane is grown principally in coast lands, the soils being largely of volcanic origin. Nearly all the cane is a purple variety. It is reproduced either from tops only or from cuttings of the whole cane; it is cut after 9 to 14 months' growth. The juice contains from 15 to 18 or 19% of sucrose; quotient of purity is about 85 to 90%; it is therefore of good quality. It is generally free from disease, but suffers from insect pests to a certain extent. The outturn of sugar varies a good deal, namely, from half a ton to as much as 5 tons per acre, and averages about one ton. Manures are but little used and the cultivation is indifferent. Considerable labour difficulties are met with.

Regarding manufacture, the cane is pressed in either steam driven iron mills of British manufacture, or in mills, driven by water power or cattle power; of these the first named greatly predominate. The juice is boiled down to a solid raw-sugar, which presumably resembles Indian "gur," in a series of flat-bottomed open pans, the process being apparently very similar to that commonly employed by the sugar boilers of the Western Districts of the United Provinces.—(J. W. LEATHER.)

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AN IMPROVED METHOD OF SOWING MAIZE.—Maize is a very important crop in the western part of the United Provinces. It is sown, as a rule, when the rains break, but a certain amount is put in May and early June after the ground has been irrigated. The seed is sown either broad-cast or is dropped into the furrows behind the plough, *i.e.*, in rows 10″ to 12″ apart. Later on the crop is weeded and the maize plants cut out where they are very thick together. The crop grows luxuriantly on good soil and attains a considerable height.

Having some slight knowledge of the methods of maize cultivation in America it occurred to me that the cultivators of this circle were growing their crop much too thick to get the best results. To test this, experiments were made on the farm

at Aligarh in 1909. One series of plots was sown in the ordinary way. In the second series the seed was sown in lines 2′ apart and later on the plants were thinned out to about 1′ apart in the rows. At harvest time, the second series yielded 40% more outturn than the first. This meant an increase of about Rs. 12 per acre.

These results were brought to the notice of Zemindars and cultivators and many expressed their willingness to try the new method of sowing. Returns now to hand from the districts of Etah, Aligarh, Meerut and Saharanpur indicate that the method has been very successful. It is hoped it will spread considerably this year. If, in addition to sowing in lines, we can induce cultivators to do regular intercultivation, a still greater increase in produce will result.—(A. E. Parr.)

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Dairy Cow tests in connection with Agricultural Shows.—In some of the shows where prizes are given to the best milking cows, the practice is to bring the cows to the show grounds on the evening previous to the show where they are milked that evening as well as again on the following morning. The milk is afterwards weighed and the sample is tested for percentage of butter fat. This is not a fair test because the cows are not in their usual surroundings and are consequently excited. It has generally been the experience of dairymen that when animals are taken from their home surroundings and milked in a strange place amidst excitement, they do not yield their usual quantity of milk. Good milkers are especially nervous in temperament and such cows are more easily upset in shows and competitions. In order to overcome these difficulties a practice is coming into vogue in parts of Australia by which the cows are milked in their usual surroundings under the supervision of officers of the show or competition both in the morning and evening of a day in the two weeks previous to the Show, and the day's butter production is taken as the basis of deciding the cow's yield.—(Editor.)

REVIEWS.

Bulletin of the Bureau of Economic and Social Intelligence of the International Institute of Agriculture, 1st Volume, No. 1, September 1910.

The International Institute of Agriculture publishes (1) a monthly Bulletin of Agricultural Statistics, (2) a Bulletin of Agricultural Intelligence and Diseases of Plants, and (3) a monthly Bulletin of Economic and Social Intelligence. The first number of the last of these is represented by the volume now under review.

In the words of the preface the object of these bulletins is "to collect and publish all information bearing upon the working of co-operative societies and other agricultural associations, in order to facilitate their organisation and development and to throw light upon the most pressing problems connected with economic and social matters." In the present volume, the countries dealt with are Germany, Austria, Denmark, the United States of America, Great Britain and Ireland, Italy and Japan. Each country, as being economically and politically independent, is dealt with under five different heads. The first head details the demographic and social conditions of the country in order to show the relations of these to the specific character of its agricultural organisations. Thus, it discusses statistically such matters as territory, and population, occupations of the people, birth and death rate, illiteracy, emigration, division of land areas as arable, vineyards, etc., principal products, classes of landholders, live stock census, fisheries, mines, manufactures, navigation and inland communications, finance, money, and weights and measures. Under the second head are presented short studies of monographs

dealing with a part or the whole field of the agricultural organisation of the country. Thus in the present volume, under the head of Germany the first study is an interesting historical and statistical sketch of the present state of agricultural co-operation in that country, which details the life and early labours of Raiffeisen, Schulze and other pioneers in the field of scientific co-operation, with special reference to the Raiffeisen Bank System. The second monograph deals with another characteristic form of co-operation in Germany—Co-operative Land Credit Societies—the "Landschaften" and "Ritterschaften." Similarly for other countries under this head, subjects of the greatest importance in connection with co-operation are dealt with. These monographs are accompanied by statistical tables giving varied information of the highest importance.

The third part deals with such problems and facts as are of immediate importance to the working of the various organisations and will in future give special attention and prominence to any new measures which have been found useful in extending the objects of these. Under this head, in the case of Germany, we find discussed Co-operative Electric Light and Power Societies—an attempt to supply suburbs and rural districts with electric power, and in the case of Italy an account of the organisation of a Central Bank of Co-operation and Labour. The fourth part deals with current up-to-date news of the co-operative movement. It gives account of recent legislation in favour of agricultural organisations, makes reference to the work accomplished by the most successful federations and to the resolutions which they have passed, gives any other items of news of importance and finally presents a bibliographical summary of the latest books dealing with the co-operative movement. The fifth part deals with subjects which, although not bearing directly on agricultural co-operation, are yet of great importance to agriculturists. Such subjects include agricultural legislation, the organisation of markets for chemical manures, seeds, implements, etc., and also the development of non-agricultural co-operative societies. Thus in the present volume, we find under this head

such subjects discussed as "The New Law on the Sale of Land in Small Lots in the Kingdom of Bavaria" and "The New Legislation for the Preservation of Peasant Properties in Austria."

The present volume deals with agricultural co-operation only, but in future numbers it is proposed to take up agricultural insurance in all its forms and in due course non-co-operative agricultural credit.

The sources of information used in the publication of the Bulletin are either (1) official, *i.e.*, supplied by governments or under their responsibility; (2) communicated by societies, co-operative or otherwise; and (3) obtained from the publications of all kinds whether official, private, or issued by associations. A complete list of authorities is quoted at the head of each section.

It need scarcely be said that this Bulletin is a piece of work of the highest importance. Compiled from the most reliable sources, it deals with agricultural economics from every point of view—historical, statistical and legislative and as a means of comparing the methods of co-operation in vogue in different countries, it will be equally useful to agriculturist and official. The Chief of the Bureau—M. G. Lorenzoni—in his preface expresses a desire for greater collaboration between the Governments and Societies on the one hand and the staff of the Bureau on the other. It is to be hoped that, considering that the work is of supreme international importance, his wish may be fully realised in the future.—(A. McKerral).

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Progress in Irrigation by Pumping in Madras, by Alfred Chatterton, Director of Industries, Madras. (A Paper contributed to the Industrial Conference held at Allahabad in December 1910.)

The object of this paper is "to put on record what has actually been done and to suggest the directions in which progress on the engineering side of the question is likely to facilitate extensions." It is stated that a regular attempt to use oil

engines for pumping water dates in the Madras Presidency from 1902 when there was only one oil engine installation worked by Government. Rapid progress has since been made in this direction. There are at present more than 250 pumping plants erected both by Government and private individuals. Up to this time oil engines working with liquid fuel, which is the residue left after the distillation of the crude petroleum, were employed. But recently suction gas plants and gas engines working with charcoal are being introduced. The introduction of steam engines does not seem possible as the price of coal is prohibitive.

It is calculated that these pumps irrigate about 12,000 acres of land. It is difficult to arrive at the actual cost of irrigation as it depends upon a large number of factors which vary with almost every installation. It is, however, roughly estimated @ Rs. 30 per acre per annum.

Mr. Chatterton takes notice of a gas pump newly invented by Mr. H. A. Humphrey. The chief advantage of this machine is that the inventor has successfully combined both engine and pump and has practically eliminated the moving parts, thereby saving the expenditure on wear and tear and lubrication. The construction of this machine is very simple and Mr. Chatterton hopes that it will come into general use in India.

It is reported that some improvements have also been made in the old methods of lifting water by modifying the construction of the common lift pump so as to permit it to be worked with a loose fitting tubular piston. It can be worked either by manual power or by a small power engine. By manual labour it can raise from 500 to 2,000 gallons of water per hour. It is most suitable for the locality where the supply of water is small. Mr. Chatterton suggests the employment of a common engine to drive a number of such pumps situated within a reasonable distance which can be connected by a wire rope. The method suggested is similar to the one employed in the oil fields of California.

The use of mechanical methods of pumping water has led to a considerable increase in the number of wells in the Madras

Presidency. A large area of land having an abundant supply of water has also been discovered. Considerable work has been done in this direction which is capable of further extension.—(EDITOR.)

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INTERIM REPORT FOR THE FIRST CROP YEAR, 1908-09, OF THE NIRA CANAL TAGAI LOANS SCHEME, POONA DISTRICT.

SUGARCANE is largely grown on the land irrigated by the Nira canal, and its cultivation is very profitable, but on account of the poverty and ignorance of cultivators most of the profits find their way into the pockets of the *sowkars* or money-lenders, who not only charge heavy rates of interest but also compel the cultivators to purchase the manures, such as oil-cakes, etc., and to sell the produce through them, charging them heavy brokerage. The result is that a very poor margin of profit is ordinarily left to the cultivator and in adverse years it is practically nil. With a view to finance the cultivators on much easier terms and to secure them their well-earned profits, the Government of Bombay sanctioned in 1908 a scheme for advancing *tagai* to sugarcane cultivators of the Nira canal. The principal feature of this scheme is that the cultivator financed by Government is asked to bring his produce to the Government shop for sale. This serves a double purpose. It secures the payment of the loan made by Government and saves the cultivator the heavy brokerage and other charges levied by local merchants. Arrangements are also made for distributing oil-cakes to cultivators at fair rates. The report before us shows that the scheme has been found to work with success. Loans are given on a long-term basis or short-term basis. Long-term loans are given to enable the cultivator to commence and complete his operations from ploughing to harvesting and is repayable within 16 months, whereas short-term loans are usually given for the purchase of manure and for crushing operations, and are repayable within 12 months. Nearly 300 cultivators took advantage of the scheme and got net profits, ranging from Rs. 50 to Rs. 300 per acre, the average net profit being Rs. 150 per acre. This

compares favourably with the profits on this crop reaped in other parts of India, which vary from Rs. 18-8-0 per acre in the Punjab, to Rs. 118 in Lower Bengal.

The scheme is thus likely to improve the material condition of cultivators in these parts in course of a few years. Several instances are quoted in the report which show that some of the cultivators financed by Government have made sufficient profit to defray the expenses and to liquidate their old debts.

The question of finding a suitable agency to take over from Government the work which is being carried on under the scheme is engaging the attention of the Government of Bombay. Pending a decision on this point the present operations will be continued.—(EDITOR.)

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IMPROVEMENTS IN AGRICULTURE IN SOUTHERN INDIA (A PAPER READ AT THE INDUSTRIAL CONFERENCE, 1908, MADRAS). BY MR. M. R. RAMKRISHNA IYER, HIGH COURT VAKIL AND SECRETARY, DISTRICT AGRICULTURAL ASSOCIATION, TINNEVELLY.

THE subject of this paper is to show how improvements can be effected in the agricultural industry of India in general and Southern India in particular. After a short introduction in which it is pointed out how the farmers in the United States of America and other advanced countries of Europe are making large profits by the application of science to agriculture, the author describes in detail what improvements are possible in this country in the various lines of operations from preparation of the land to harvesting the crop. He observes that in some parts of this country the agricultural practices are so good that it is difficult to suggest an improvement, but at the same time he holds it as a fact that owing to the want of knowledge on the part of the ryot of the principles of agriculture, the agricultural practices have remained almost stationary during the last thirty years, and that considerable improvement is possible by adopting methods of proved value. The following are most of the salient points of improved farming suggested by the author as applicable to the circumstances of this country. They are in substance such as have been tested

on Government farms and are being recommended by the Department.

The land should be ploughed deeply by an improved iron plough which stirs the soil to a great depth, which is an advantage over a country plough. To give a fine tilth a grubber or cultivator or a country plough can be used. Though deep ploughing is not often needed, stirring of the soil to some depth is necessary, to enable it to receive a large portion of rainfall, a thing absolutely necessary especially in dry areas. It is desirable to enclose lands with fences as far as possible, but what is more needed is that all the lands including dry lands should be divided into plots and bunded with small embankments to allow the rain water to sink into the soil, and to minimise the risks of the soil fertilisers being carried away by the first rains. The land should be frequently harrowed to produce a soil mulch to avoid evaporation of moisture from the soil. The author recommends for this operation the country "Guntaka," of the ceded districts or the new harrow designed by Mr. Sampson, Deputy Director of Agriculture, Madras. The application of humus or vegetable matter especially to dry lands is emphasised. For this purpose not only leguminous crops should be raised on the land itself, but to provide leaf manure legumes like *kolinji* (*Tephrosia purpurea*) and *avarai* (*Cassia auriculata*) ought to be grown on all waste unculturable lands. Considerable stress is laid upon the value of conserving cattle manure, solid and liquid, which is at present wasted in burning or otherwise. For concentrated manures when needed, oil-cakes and bones in the form of bone-meal are recommended. Sowing should be done in drills as this facilitates interculture, which is necessary not only to aerate the soil but also to conserve moisture. In transplanted paddy, transplantation with single seedlings is more profitable than that with a bunch of 10 or 12 which is to some extent common in Southern India. The value of using selected seed, observing rotation and growing variety of crops is fully explained. Finally the author looks to Government for help by opening seed farms for distribution of selected seed, by investigations and experiments in various agricultural

stations to find out improved methods, by disseminating results of proved value through publications, demonstrations and agricultural associations and by spreading agricultural education among rural classes.—(EDITOR.)

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BULLETIN ON ENTOMOLOGICAL RESEARCH.

THIS bulletin is issued by the Entomological Research Committee (Tropical Africa) appointed by the Colonial office and deals with the insects of Africa which injure men or domestic animals by conveying or causing disease, or which attack economically valuable plants. Three numbers have been issued, dated April, July, October, 1910; each consists of about 80 pages with about five plates, and the paper, print and plates are excellent. The subscription is small, ten shillings for the first year.

The bulletin is of interest to entomologists in all parts of the world as well as to residents in Africa: it is not meant to be popular but is a record of scientific work.

The first number commences with a paper on "The Pupal Stages of West African Culicidæ" with seven plates; a paper on the blood-sucking diptera met with in the Eastern and South-Eastern Abyssinia follows, and then "Notes on two West African Hemiptera injurious to Cocoa." New coccids and fruit-flies from Africa are described, a new *Cordylobia*, and the number closes with a note on parasites of wild silk-worms and a list of collections received.

The second number opens with an account of the fleas found on three species of *Mus*; the bionomics of two species of Tabanus follows, then a survey of the more important families of *Acari*, an account of a mealy bug injurious to the Lebbek trees of Cairo, and notes on the habits of *Glossina fusca*.

The third number opens with an article on West African fruit-flies by the Director of the Medical Research Institute, Lagos, the habits of *Glossina morsitans* are described, and an account is given of the investigation into the origin of sleeping-sickness infection in the Luangwa valley; and the movements of *Glossina morsitans* are described as well as the scale insects of

Uganda; there are comments by Mr. Green of Ceylon on the earlier paper on Uganda *Coccidæ* and a precis of reports submitted by district residents concerning Tsetse fly and cattle disease in the Nyasaland Protectorate. Notes on various topics conclude the number.

The publication may fill a useful purpose in affording a medium for papers on *Glossina* and other biting flies, and it may be hoped it will ultimately confine itself to one line. It must either become purely economic, medical or faunistic of Africa: no publication can successfully cover the whole ground. To medical men interested in biting flies the bulletin will be of value and it should find a place in some of the libraries in this country. The three numbers are rather mixed, but it may be hoped that the bulletin will eventually find its line and fill a want. Entomological literature grows so fast that it is hard to keep track of it all, but it is not difficult to follow a publication that has a line of its own and keeps to it, which this bulletin should eventually do.—(H. M. Lefroy.)

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A Monograph of the Culicidæ or Mosquitoes. By Fred. V. Theobald. Vol. V, pp. xv + 646 + 6 plates. London, 1910; *British Museum* (Nat. History). Price £1-5-0.

When Mr. Chamberlain sent out his circular from Downing Street in 1898 requesting all Colonial authorities "to be good enough to take the necessary steps at your early convenience to have collections made of the winged insects . . . . which bite men or animals," we doubt whether even Entomologists foresaw the great importance of the issues involved or the vast number of new forms which awaited investigation. At that time the species recorded from India totalled four only. In 1900 Colonel Giles was able to record 32 species and stated in the Journal of the Bombay Natural History Society (Vol. XIII, p. 603) that he had "little doubt the final total of species will be found not far off a hundred." This estimate can only be described as a modest one; we know no less than 168 different species or varieties sufficiently distinct to be accounted worthy of a name and which occur within the limits of

India, Burma, and Ceylon. Nor have we any grounds for considering that this number is more than a fraction of the forms actually present. In spite of the good work done by many investigators in India during the last decade, our knowledge of Indian Mosquitoes from a systematic point of view is still very scrappy and incomplete and the constant stream of new discoveries is the best proof of the many other facts awaiting to be discovered. All of us who live in India are only too painfully familiar with the appalling loss of life and health caused annually by malaria and other mosquito-borne diseases. At the present stage of our fight against this loss it is important to have at our command every item of information that we can gather about mosquitoes in India, and every resident in India can help in this. In the preface to the volume under review we read :—" The localities from which new collections are specially desired by the Museum are . . . . East Indies." We can all help by collecting mosquitoes and sending them in to the British Museum with notes on their occurrence, *e.g.*, where found, whether in bungalows or in jungle, at what time of year, whether they bite and, if so, at what time of day, where they breed, what preys on them, etc. Mosquitoes are ubiquitous in India; like the poor, they are always with us, in the hills or plains, in the hot weather, the rains or the winter, and accurate notes on the distribution and habits of even the commonest species will be welcome.

It is greatly to be regretted that the classification of the Culicidæ should have been carried out hitherto on characters of so trivial a nature as have been employed. In his introduction the author tells us that "the system of classification by scale-structure apparently works out well from a practical point of view." From the point of view of the ordinary non-entomological inquirer who only wishes to be able to name his specimens, we admit that the use of a purely artificial system of keys based on scale-structure is as good as any other, but we cannot concede that the scheme can be considered sound from a strictly scientific standpoint. Such a multiplication of genera based on trivial characters could only produce a state of chaos were it applied to

the classification of any other group of insects. We doubt also the true affinities of some of the species thus artificially brought together and would instance the two species given on page 227 under the genus *Pseudohowardina*, one of which occurs in North America, the other in Ceylon, two faunal regions which otherwise have practically nothing in common.

The present volume is especially valuable as containing a general résumé of our knowledge of the Mosquitoes of the world, the new species or those described since the publication of Volume IV being described at length and the others briefly noted, references to literature and localities being recorded under each. The book is thus a catalogue of practically all the species known, grouped in the systematic order considered most natural by the author after his long study of this family.

We note by the way, that the author states in his Introduction that he "has only been able to devote his leisure hours" to this study. Surely it would repay us as a nation to devote a little more serious attention to the study of insects which generally pay only too much attention to us!

We cannot congratulate Mr. Theobald on a happy selection of some of his generic and specific names. *Culiciomyia*, *lophoventralis*, etc., are barbarous hybrids between Greek and Latin, whilst names like *freetownensis*, *annuloabdominalis*, *leptosomatomyia*, whilst unnecessarily long and cumbrous, do not seem to possess the redeeming merit of pointing out any special character which may assist the student in recognising the species concerned.

There are, on the whole, few misprints, but Eastern localities, as usual in books of this character, often get transformed into strange shapes; thus, Pundaluoya becomes Pundabroya (p. 221, l. 7), Bhim Tal becomes Brim Tal (p. 159, l. 15), etc.

We notice one error of reduplication. *Trichorhynchus fuscus*, Th., from Peradeniya, figuring in two places, on page 262 and again on page 269.—(T. Bainbrigge Fletcher.)

LIST OF AGRICULTURAL PUBLICATIONS IN INDIA FROM THE 1st AUGUST 1910 TO THE 31st JANUARY 1911.

No.	Title.	Author.	Where Published.
	General Agriculture.		
1	The Agricultural Journal of India, Vol. V, Part IV, and Vol. VI, Part I. Price, per part, Rs. 2-0. Annual subscription, Rs. 6.	Agricultural Research Institute and College, Pusa, Bengal.	Messrs. Thacker, Spink and Co., Calcutta.
2	Area & Yield of Certain Principal Crops in India for various periods, from 1895-96 to 1909-10. Price, 4 annas.	Commercial Intelligence Department of the Government of India.	Government Printing, India, Calcutta.
3	Prices and Wages in India. Price, 2 rupees.	Compiled in the Office of the Director-General of Commercial Intelligence.	Ditto.
4	Indigo Reports	Rawson and Bergtheil ...	Baptist Mission Press, Calcutta.
5	Report of the Indigo Research Station, Sirseah, for 1909-10.	C. J. Bergtheil ...	Ditto.
6	Sixth Report of the Sirseah Sub-Committee to the Directors of the Behar Planters' Association, for the year ending 31st March 1910.	Behar Planters' Association, Muzafferpore.	Ditto.
7	*Oryza Sativa.*—Literature on the Races of Rice in India. Agricultural Ledger No. 1 of 1910. First half, A-K. Price, 12 annas.	Compiled in the Office of the Reporter on Economic Products to the Government of India.	Government Printing, India, Calcutta.
8	Guano and Edible Frogs. Agricultural Ledger Nos. 1 and 2 of 1911. Price, 1 anna.	I. H. Burkill, M.A. ...	Ditto.
9	Agricultural Statistics of India for the years 1904-05 to 1908 09, Vol. I. Price, Rs. 2.	Compiled in the Office of the Director-General of Commercial Intelligence.	Ditto.
10	Memorandum on Indian Wheat for the British Market. Bulletin No. 20 of the Agricultural Research Institute, Pusa. Price, 4 annas.	Sir James Wilson, K.C.S.I.	Ditto.
11	Report of the Agricultural Research Institute and College, Pusa (including Report of the Imperial Cotton Specialist), for 1909-10. Price, 4 annas.	Inspector-General of Agriculture in India.	Ditto.
12	Memorandum regarding Leading Eucalypts suitable for India. Bulletin No. 21 of the Agricultural Research Institute, Pusa. Price, 4 annas.	F. Booth-Tucker ...	Ditto.
13	Report on the Progress of Agriculture in India for 1909-10. Price, 6 annas.	B. Coventry, Officiating Inspector-General of Agriculture in India.	Ditto.
14	Quarterly Journal of the Department of Agriculture, Bengal, Vol. IV, No. 1 (July 1910), and No. 2 (October 1910). Price, 6 annas per copy.	Department of Agriculture, Bengal.	Bengal Secretariat Press, Calcutta.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title.	Author.	Where Published.
	General Agriculture—contd.		
15	Annual Report of the Department of Agriculture, Bengal, for the year ending 30th June 1910. Price, 8 annas.	Department of Agriculture, Bengal.	Bengal Secretariat Book Depôt, Calcutta.
16	Notes on Agricultural Shows with Recommendations for Future Exhibitions. Departmental Record No. 1 of 1909. (Not for sale).	E. J. Woodhouse, B.A. ...	Bengal Secretariat Press, Calcutta.
17	Annual Report of the Agricultural Stations in charge of the Deputy Director of Agriculture, Bengal, for the year 1909-10. Price, 4 as.	F. Smith, B.Sc., F.H.A.S. ...	Bengal Secretariat Book Depôt, Calcutta.
18	Annual Report of the Kalimpong Demonstration Farm for the year 1909-10. Price, 8 annas.	P. W. Goodwin ...	Ditto.
19	Some Suggestions as to the Organization of Agricultural Exhibitions in Bengal. Departmental Record No. 1 of 1910. (Not for sale).	E. J. Woodhouse, B.A. ...	Bengal Secretariat Press, Calcutta.
20	Report on the Administration of the Department of Agriculture, United Provinces of Agra & Oudh for the year ending 30th June 1910. Price, 8 annas.	Department of Agriculture, United Provinces of Agra & Oudh.	Government Press, United Provinces, Allahabad.
21	Annual Report on Aligarh Agricultural Station, for the year ending 30th June 1910. Price, 8 annas.	Ditto ...	Ditto.
22	Annual Report on the Partabgarh Agricultural Station for the year ending 30th June 1910. Price, 8 annas.	Ditto ...	Ditto.
23	Notes on Improvement of Cattle in the United Provinces. Price, 6 pies. Bulletin No. 25 of 1910 of the United Provinces Department of Agriculture.	W. H. Moreland, B.A., LL.B., C.I.E., I.C.S.; and E. W. Oliver, M.R.C.V.S., F.Z.S.	Ditto.
24	Report on the Operations of the Department of Agriculture, Punjab, for the year ending 30th June 1910. Price, 3 annas.	Department of Agriculture, Punjab.	Civil & Military Gazette Press, Lahore.
25	Annual Report of the Lyallpur Agricultural Station, for 1909-10. Price, 13 annas and 6 pies.	Ditto ...	Ditto.
26	Annual Report of the Department of Agriculture, Bombay, for 1909-10. Price, 8 annas.	Department of Agriculture, Bombay.	Government Central Press, Bombay.
27	Season and Crop Report of the Bombay Presidency for 1909-10. Price, 7 annas.	Ditto ...	Ditto.
28	Annual Report on the Experimental Work of the Surat Agricultural Station for the year 1909-10. Price, 14 annas.	Ditto ...	Ditto.
29	Annual Report on the Experimental Work of the Dharwar Agricultural Station, for the year 1909-10. Price, 14 annas.	Ditto ...	Ditto.
30	Annual Report on the Experimental Work of the Dhulia Agricultural Station, for the year 1909-10. Price, 10 annas.	Ditto ...	Ditto.
31	Annual Report on the Experimental Work of the Nadiad Agricultural Station, for the year 1909-10. Price, 10 annas.	Ditto ...	Ditto.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title.	Author.	Where Published.
	General Agriculture—contd.		
32	Annual Report on the Experimental Work of the Dohad Agricultural Station, for the year 1909-10. Price, 10 annas.	Department of Agriculture, Bombay.	Government Central Press, Bombay.
33	Annual Report on the Experimental Work of the Gokak Canal Agricultural Station, for 1909-10. Price, 8 annas.	Ditto ...	Ditto.
34	Annual Report on the Experimental Work of the Mirpurkhas Agricultural Station, for the year 1909-10. Price, 7 annas.	Ditto ...	Ditto.
35	Annual Report on the Experimental Work of the Daulatpur Reclamation Station, for the year 1909-10. Price, 10 annas.	Ditto ...	Ditto.
36	Annual Report on the Experimental Work of the Manjri Agricultural Station, for the year 1909-10. Price, 4 annas.	Ditto ...	Ditto.
37	Annual Report on the Experimental Work of the Lonavla Agricultural Station, for the year 1909-10. Price, 4 annas.	Ditto ...	Ditto.
38	Annual Report on the Kirkee Civil Dairy, for 1909-10. Price, 4 annas.	Ditto ...	Ditto.
39	Annual Report on the Work of the Agricultural College Station, for 1909-10. Price, 8 annas.	Ditto ...	Ditto.
40	Annual Report on the Experimental Work of the Ganesh Khind Botanical Station, for 1909-10. Price, 5 annas.	Ditto ...	Ditto.
41	Annual Report on the Experimental Work of the Bassein Botanical and Agricultural Station, for 1909-10. Price, 4 annas.	Ditto ...	Ditto.
42	An Examination of the Seed Supply of the Broach District. Bulletin No. 37 of 1910. Price, 4 annas.	G. D. Mehta, L.Ag., B.A., N.D.A., N.D.D.	Ditto.
43	Experiments with the Water Finder of Messrs. Mansfield & Co., in the Trap Area of Western India. Bulletin No. 38 of 1910. Price, 5 annas.	H. K. Mehta, M.A., B.Sc.	Ditto.
44	A Feeding Meal from the Scum obtained in *Gul* Boiling. Leaflet No. 5 of 1910.	Department of Agriculture, Bombay.	Ditto.
45	Guinea-worm. Leaflet No. 6 of 1910.	Ditto ..	Ditto.
46	Report on the Operations of the Agricultural and Civil Veterinary Departments, Madras, for the official year 1909-10. Price, 6 annas.	Department of Agriculture, Madras.	Government Press, Madras.
47	The Conservation of Cattle Urine. Leaflet in English, Tamil, Telugu and Malayalum.	H. C. Sampson, B.Sc. ...	Ditto.
48	Experiences of Single Seedling Planting. Leaflet in English, Tamil and Telugu.	Kolandavelu Udayar ...	Ditto.
49	Useful facts learnt from the Experimental Cultivation at Taliparamba. Leaflet in Canarese and Malayalum.	H. C. Sampson, B.Sc. ...	Ditto.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

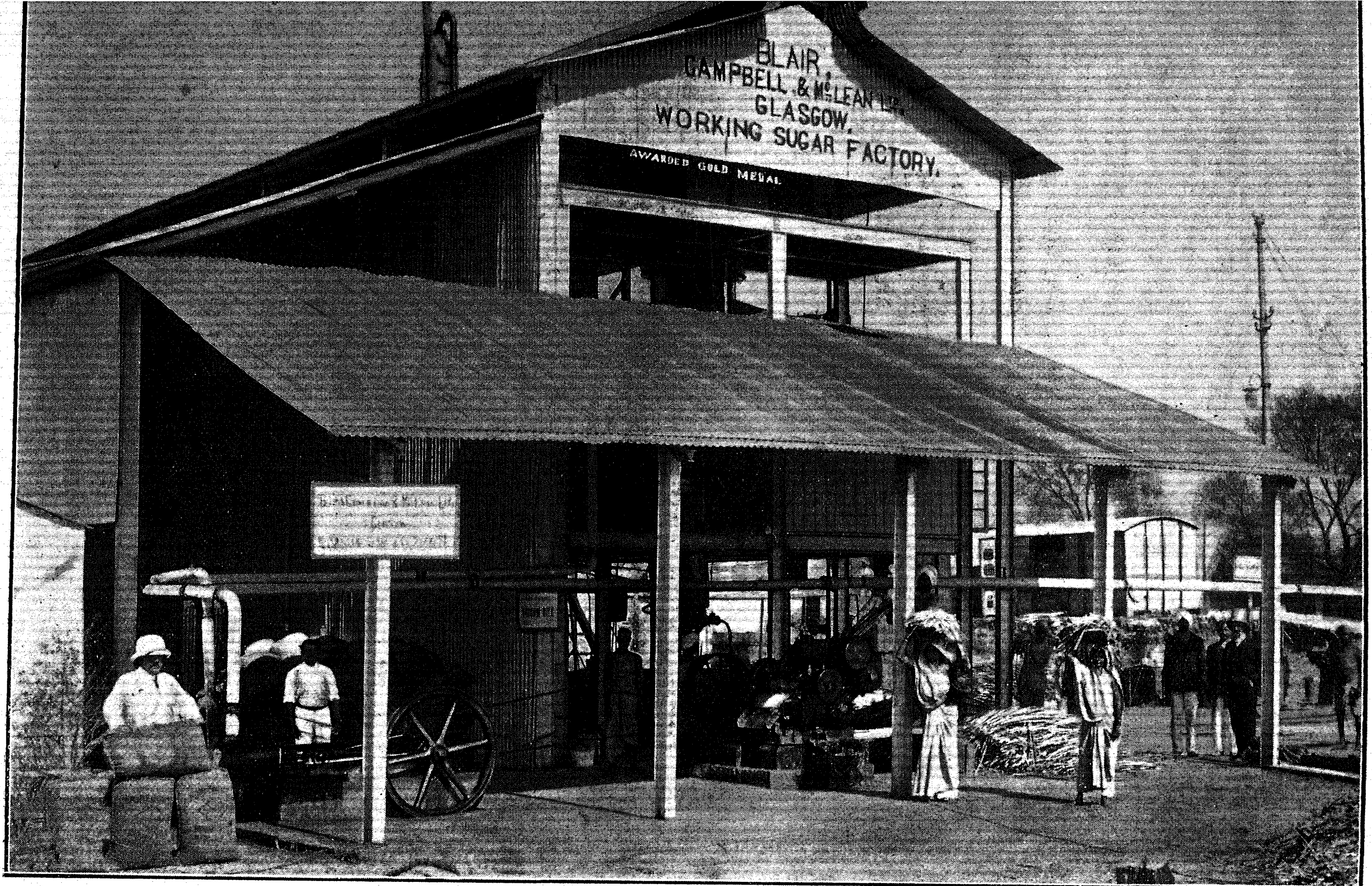
No.	Title.	Author.	Where Published.
	General Agriculture—contd.		
50	Useful facts learnt from experimental cultivation at Palur. Leaflet in English and Tamil.	H. C. Sampson, B.Sc. ...	Government Press, Madras.
51	Light Traps. Leaflet in English ...	C. A. Barbar, M.A., F.L.S., D.Sc.	Ditto.
52	Individual Manuring of Paddy. Leaflet in English and Tamil.	H. C. Sampson, B.Sc. ...	Ditto.
53	Practical Lessons drawn from Experiments at the Central Farm, Coimbatore. Leaflet in Tamil, Malayalum, Telugu and Canarese.	R. W. B. C. Wood, B.A. ...	Ditto.
54	Useful facts learnt at Koilpatty. Leaflet in Tamil.	H. C. Sampson, B.Sc. ...	Ditto.
55	Report on the working of the Department of Agriculture, Central Provinces, for the year 1909-10. Price, 1 rupee.	Department of Agriculture, Central Provinces.	Central Provinces Secretariat Press, Nagpur.
56	Report on the Agricultural Stations in the Central Provinces and Berar, for the year 1909-10. Price, 1 rupee.	Ditto ...	Ditto.
57	Report on the Management of the Provincial and District Gardens, Central Provinces, for the year 1909-10. Price, 8 annas.	Ditto ...	Ditto.
58	The Improvement in the quality of Wheat exported from the Central Provinces. Bulletin No. 4. Price, 1 rupee.	G. Evans, B.A. ...	Ditto.
59	*Agricultural Gazette*—A monthly publication. Price, 2 annas per copy.	Department of Agriculture, Central Provinces.	Ditto.
60	Annual Report of the Department of Agriculture, Eastern Bengal and Assam for the year ending 30th June 1910. Price, 8 annas.	Department of Agriculture, Eastern Bengal and Assam.	Government Press, Eastern Bengal and Assam, Shillong.
61	Annual Report of the Dacca Agricultural Station for the year ending 30th June 1910. Price, 2 annas.	Ditto ...	Ditto.
62	Annual Report of the Jorhat Agricultural Station for the year ending 30th June 1910. Price, 2 annas.	Ditto ...	Ditto.
63	Annual Report of the Rajshahi Agricultural Station for the year ending 30th June 1910. Price, 2 annas.	Ditto ...	Ditto.
64	Annual Report of the Burirhat Agricultural Station for the year ending 30th June 1910.	Ditto ...	Ditto.
65	Annual Report of the Shillong Fruit Garden for the year ending 30th June 1910.	Ditto ...	Ditto.
66	Annual Report of the Upper Shillong Agricultural Station for the year ending 30th June 1910. Price, 2 annas.	Ditto ...	Ditto.
67	Annual Report on the Tropical Plantation at Wahjain for the year ending 30th June 1910. Price, 2 annas.	Ditto ...	Ditto.
68	Central Seed Depôt, Dacca. Leaflet No. 2 of 1910.	Ditto ...	Ditto.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title.	Author.	Where Published.
	General Agirculture—contd.		
69	*Hints on the Cultivation of the Fig Tree. Leaflet No. 4 of 1910.	Department of Agriculture, Eastern Bengal and Assam.	Government Press, Eastern Bengal and Assam, Shillong.
70	Report on the Operations of the Department of Agriculture, Burma, for the year ending 30th June 1910. Price, 6 annas.	Department of Agriculture, Burma.	Government Press, Burma, Rangoon.
71	Scientific Report of the Mandalay Agricultural Station for the year 1909-10.	Ditto ...	Ditto.
72	Papers on the Manufacture of Jaggery from the juice of the Toddy-palm with special reference to the effects of the Industry on the Timber Supply of the Dry Zone of Burma. Bulletin No. 3 of 1910. Price, 2 annas.	Ditto ...	Ditto.
73	Agricultural Surveys, No. 2 Sagaing District.	Ditto ...	Ditto.
	Agricultural Chemistry.		
74	The Salt Lands of the Nira Valley. Bulletin No. 39 of 1910 of the Department of Agriculture, Bombay. Price, 5 annas.	Harold H. Mann, D.Sc., & V. A. Tamhane, L. Ag.	Government Central Press, Bombay.
75	Manufacture of *Gur*. Leaflet No. 5 of 1910 of the Department of Agriculture, Bengal.	C. S. Taylor, B.A. and N. C. Chowdhury.	Bengal Secretariat Press, Calcutta.
76	Use of Shallow Pan for *Gur* making. Leaflet No. 6 of 1910 of the Department of Agriculture, Bengal.	N. C. Chowdhurry ...	Ditto.
77	The Composition of Indian Rice. The Agricultural Ledger No. 5 of 1908-09. Price, 4 annas.	David Hooper, F.C.S. ...	Government Printing, India, Calcutta.
	Mycology.		
78	First Experiments in the Treatment of Grape-vine Mildew in the Bombay Presidency. Bulletin No. 36 of 1910 of the Department of Agriculture, Bombay. Price, 14 annas.	W. Burns, B.Sc. ...	Government Central Press, Bombay.
79	The Ring Disease of Potatoes. Bulletin No. 1 of the Mysore Department of Agriculture.	L. C. Coleman, M.A., Ph.D.	Mysore Government Press, Bangalore.
80	Diseases of Areca Palm, I Koleroga. Price, 2 rupees.	Ditto ...	Ditto.
	Economic Botany.		
81	Millets of the Genus Setaria in the Bombay Presidency and Sind. Memoirs of the Imperial Department of Agriculture, Botanical Series, Vol. IV, No. 1. Price, 1 rupee.	G. A. Gammie, F.L.S. ...	Messrs. Thacker, Spink & Co., Calcutta.
	Entomology.		
82	Fasaler Poka. Text-Book. (Bengali).	C. C. Ghosh, B.A. ...	Indian Gardening Association, 162, Bowbazar Street, Calcutta.

LIST OF AGRICULTURAL PUBLICATIONS—*concld.*

No.	Title.	Author.	Where Published.
	Entomology—concld.		
83	Instructions for rearing Eri-Silk Worms. Leaflet in English, Hindi and Bengali.	H. Maxwell Lefroy, M.A., F.E.S., F.Z.S.	Government Printing, India, Calcutta.
84	Eri Seed exchange	Ditto ...	Ditto.
85	The Rice Hispa. Leaflet No. 1 of 1910 of the Department of Agriculture, Bengal.	H. L. Dutt	Bengal Secretariat Press, Calcutta.
86	The Rice Fulgorid. Leaflet No. 2 of 1910 of the Department of Agriculture, Bengal.	Ditto ...	Ditto.
87	Sugar-cane Borer. Leaflet No. 3 of 1910 of the Department of Agriculture, Bengal.	Ditto ...	Ditto.
88	Pests of Pulses. Leaflet No. 4 of 1910 of the Department of Agriculture, Bengal.	Ditto ...	Ditto.
89	The Rice Hispa, Cultivator's Leaflet No. 24 of 1910 of the Department of Agriculture, Burma.	Department of Agriculture, Burma.	Government Press, Burma, Rangoon.
90	The Rhinoceros Beetle (*Oryctes Rhinoceros*, Linn) and its ravages in Burma. Bulletin No. 4 of 1910.	Ditto ..	Ditto.
91	Practical Hints on Bee-keeping in Simla. Bulletin No. 2 of 1910.	Department of Agriculture, Punjab.	Civil and Military Gazette Press, Lahore.
92	Notes on the Silk-worm rearing in the Punjab. Bulletin No. 3 of 1910.	Ditto ...	Ditto.
93	Some Common Insect Pests which attack food-grains. Leaflet No. 3 of 1910 in English, Bengali and Assamese.	Department of Agriculture, Eastern Bengal and Assam.	Government Press, Eastern Bengal and Assam, Shillong.



A. J. I.

FRONT VIEW OF THE SUGAR FACTORY.—See page 277.

THE ALLAHABAD AGRICULTURAL CONFERENCE.

By W. H. MORELAND, B.A., LL.B., C.I.E., I.C.S.,
Director of Land Records and Agriculture, United Provinces.

THE Agricultural Conference which was held at Allahabad in connection with the recent Exhibition was something of a novelty, so far at least as the United Provinces are concerned. Its object was to bring together a large and representative body of land-holders, and to direct their attention firstly to the more important problems presented by the agriculture of the province; and, secondly, to the solutions or attempted solutions of some of those problems which could be seen at the Exhibition. The general idea was that the mornings should be devoted to discussion, while the afternoons were occupied by special demonstrations illustrating the subjects that had been considered in the morning.

A conference on these lines requires a certain amount of preparation, and it may interest officers in other provinces to know the lines on which it was organised. The first question that arose was the issue of invitations: it was recognised that, while a large proportion of these must necessarily be issued by the department, others must be issued by independent agencies if the Conference was to be really representative and not open to the reproach that it consisted merely of a few friends of the department. Accordingly the invitations fell into two classes,—those selected by the department and those placed at the disposal of other bodies.

The first class included, firstly, the members of the Legislative Council and the principal title-holders of the province, invitations to whom were as a matter of courtesy issued by the Local Government; secondly, a large number of officials, includ-

ing the officers of all the agricultural departments in India, and the managers employed by the provincial Court of Wards; thirdly, those non-official gentlemen who are directly connected with the department, including the governors of the agricultural college and the honorary visitors to the various agricultural stations; fourthly, the representatives of exhibitors in the Agricultural Court; and lastly, a large number of gentlemen who are accustomed to co-operate with the department in various matters. The second class included the nominees of the Upper India Chamber of Commerce, of the various agricultural associations and of the district exhibition committees.

The results of this selection were on the whole highly satisfactory. The bulk of the Conference consisted of country gentlemen, not over-anxious to mount the platform but ready to listen to what was said and to study the demonstrations from a very practical standpoint.

The selection of subjects was a matter of some difficulty. It was recognised that the attention of the audience must be concentrated on particular points, and the number of points on which discussion appeared to be desirable was so large as to render the choice embarrassing. The course adopted was to assign each day to one or two main subjects, and to select three or four aspects of these subjects for detailed discussion. Then two or three speakers, chosen for their special knowledge of the subject, were invited beforehand to contribute the opening papers of each discussion; and following on their papers other speakers were invited from the audience, each speaker being limited to five minutes. With these arrangements, the discussions proceeded on the whole in a satisfactory manner: some nonsense was talked but that was inevitable, and succeeding speakers were usually quick to detect it.

The Conference opened on the 13th January 1911, when Sir John Hewett, the Lieutenant-Governor, took the chair and gave a brief address, in which he laid stress on the necessity that agriculture should move with the times and adapt itself to new conditions. His Honour then vacated the

chair, which (in the unavoidable absence of Mr. Leslie Porter, the Senior Member of the Board of Revenue) was occupied by Mr. Brownrigg, the Commissioner of Allahabad. The remainder of the session was devoted to discussing questions of administrative importance, the relations of the department with the people, the organisation of the people so as to obtain the full benefit of the department's activity, and the creation of the profession of estate agent. It fell to the present writer to introduce each subject in turn: the most noteworthy papers were those contributed by Mr. Hose, the Chief Secretary to Government, on agricultural associations, and by Mr. Pim, Joint Secretary to the Board of Revenue, on the training of estate agents; but valuable contributions were also made by Sir Tasadduk Rasul Khan and Rai Sri Ram Bahadur, two representatives of the Talukdars of Oudh. The speakers who offered themselves at this session had not in some cases grasped the division of subjects, but their remarks were, as a rule, valuable in showing the public recognition of the work of the department and the general desire for an extension of its activities.

The main subjects for discussion on the second day were wheat and cotton, and the chair was appropriately taken by Sir Alexander McRobert, a leading representative of the business interests of Cawnpore. The discussion on wheat was opened by Mr. Albert Howard, the Imperial Economic Botanist, who gave a popular account of his work at Pusa and indicated that more and better wheat could be grown in North India than is now the case. He was followed by Rai Nathi Mal Bahadur, a prominent representative of Indian commerce; and the subsequent discussion brought out clearly the general opinion as to the superiority of Muzaffarnagar wheat to the varieties grown in other parts of the provinces.

The attention of the Conference was then directed by Dr. Parr, the Deputy Director of Agriculture in charge of the Western Circle, to the possibilities of obtaining an increased yield from the indigenous cottons; and he was followed by Mr. Bevis, a partner in the well-known Elgin Mills, who urged

the importance of increased production. After the discussion on this subject had closed, Mr. Shakespear called attention to the utilisation of cotton seed, and indicated the conclusions to be drawn from the experimental cotton-seed-oil factory which his firm was conducting on behalf of Government. No serious difficulty had been found in the technical processes; the oil was readily marketable from the start, and the market for cake was beginning to develop on satisfactory lines.

The third session of the Conference was devoted to co-operation, the chair being taken by Mr. D. C. Baillie, Member of the Board of Revenue. This discussion was marked by the contributions from men of practical experience in organising and managing co-operative societies; thus Rai Ishar Sahai Bahadur described his successful work in Fatehpur; Mr. A. C. Mukerji gave his experience as Manager of the Kashi (Benares) Co-operative Bank, and Mr. A. H. C. Hamilton described the working of the Prayag (Allahabad) urban society. Interesting papers were also contributed by Munshi Kabul Ahmed (Sandila), Munshi Ganga Prasad (Mainpuri) and Rai Kali Charan Sahib (Unao); and the general discussion showed the extent to which the co-operative movement has already won appreciation among the people.

An afternoon session was devoted to entomological questions, the chair being taken by Mr. Coventry, the Officiating Inspector-General of Agriculture in India. Mr. Fletcher, the Supernumerary Entomologist, Pusa, gave an interesting lecture on insect pests, referring specifically to the sugar-cane grass-hopper and the potato moth, two pests which are very active in the province at the present time. The lecture was followed by a brief discussion on the suitability to the province of the *Eri* silk industry.

The fourth day of the Conference was devoted to questions affecting the sugar industry, Dr. Leather, the Imperial Agricultural Chemist, being in the chair. The first subject was improvements in cultivation: Mr. Clarke, the provincial Agricultural Chemist, described some of his preliminary results

showing the great differences in the value of different varieties, the possibility of economising seed-canes, and the importance of proper manuring This subject attracted few speakers, and the Conference turned to consider the question of making *gur* suitable for refining into sugar. Mr. McGlashan of the Cawnpore Sugar Works, read an instructive paper in which he explained the drawbacks incident to refining from ordinary *gur*, and also the difficulties which the cultivator would have to face in changing his practices. After a short discussion on the subject, the indigenous system of sugar-making was considered and roused considerable interest. Mr. Dickinson, who represented Messrs. Broadbent of Huddersfield at the Exhibition, opened the subject by explaining the advantages to be derived from the introduction of the centrifugal: and then Rai Ragho Prasad Narain Singh Bahadur advocated from personal experience the adoption of the Hadi processes of sugar-manufacture, which were also recommended by Mr. Sealy of Gorakhpur, Pandit Durshan Lal Dube of Rewah, B. Janki Prasad of Fatehpur-Sikri and B. Pheku Ram of Jaunpur, all of whom have experience of working these processes. On the other hand, representatives from Bareilly, one of the chief centres of the industry, criticised these processes from the commercial side, and Mr. Allen, the Collector of Bareilly, expressed the opinion that there was not much to choose between the Hadi processes and those worked in Bareilly, but that the introduction of the centrifugal was an undoubted improvement for work on a fairly large scale. Mr. Hadi replied to the criticisms which had been offered on his processes, and a most interesting discussion was then brought to a close.

The Conference then considered the introduction of small modern factories. Mr. Hulme, the Engineer in charge of the Exhibition factory, described the processes carried on in it, emphasising the fact that with the exception of quicklime no chemicals of any sort were used. His paper produced little discussion, but the crowd of visitors at the factory on this and subsequent afternoons showed the interest which it had aroused.

The fifth day was devoted to the consideration of implements and machinery, Mr. McLeod, the Chief Engineer to Government, being in the chair. The discussions were introduced by the present writer who pointed to the progressive rise in wages as being a factor of fundamental importance in determining the future of agriculture. Mr. Milligan, Deputy Director of Agriculture, followed with a paper indicating the effect of high wages in the Punjab, and the consequent development of the use of machinery; and after remarks by various speakers, Mr. Burt, the Deputy Director in charge of the Agricultural Court of the Exhibition, gave an account of the different classes of implements that were shown, and described a mechanical installation recently set up by a land-holder near Cawnpore who, beginning with an oil-engine and pump, had added a flour mill, cotton gins, a small grinding mill and a chaff-cutter.

The subject of water-lifts was then introduced by Mr. Chatterton, Superintendent of Industrial Education, Madras, who described the progress made in introducing pumping-plants in Southern India. A discussion followed on the difficulties in bringing implements into general use, which brought out very clearly the need for simplicity in construction and for the provision of facilities for repairs. Following on this Mr. Molony, Commissioner of Gorakhpur, read a paper on wells in which he explained the different ways in which Government was prepared to assist construction; and the session closed with a paper by Nawab Fateh Ali Khan Kazilbash, describing the advantages he had secured by having his wells bored.

The closing session of the Conference was devoted to questions relating to cattle, and the chair was occupied by Rai Sundar Lal Bahadur, one of the most prominent citizens of Allahabad. The discussion on the first subject, the protection of cattle from contagious disease, was characterised by cordial appreciation of the work of the Civil Veterinary Department; while that on cattle-breeding brought out little beyond the needs, already recognised, for more grazing and better bulls.

The question of providing dairies for the cities of the provinces attracted wider interest as the high price of *ghi* is the subject of general complaint. Mr. Smith, the Military Dairy Expert, urged that legislation to prevent adulteration was a necessary step; and it may be mentioned here that the chairman of the day has since introduced a Bill dealing with this subject in the provincial Legislative Council. B. Moti Chand of Benares urged that the dairy industry was particularly suited to private enterprise; and Mr. Chatterton suggested that the supply of milk could be simplified by the use of milk-powder, a special demonstration of which was given in the afternoon. The discussion had eventually to be closed owing to want of time, and the Conference then broke up after the chairman had thanked its organisers and suggested that similar conferences should be held periodically in different centres of the province.

The question may be raised: was the Conference worth the trouble? An answer to this question must not be looked for merely in the proceedings;* the success of the Conference is to be judged by its effect on the large majority of the members who took no active part in the proceedings, and that effect is not likely to manifest itself immediately. But judging from the enquiries made during and after the Conference, the effect has been considerable; a large number of intelligent men are now thinking over the agricultural problems of the localities in which they live, and seeking the help of the department in applying the solutions which they heard of at the Conference; and it is not, I think, too much to say that the whole current of public opinion has been concentrated and directed on more definite lines. And so far as the department is concerned, the Conference has been of very real value in bringing the officers into closer touch with many of the natural pioneers of agricultural development, and in enabling them to realise more clearly than before the attitude of the people and the nature of their needs for assistance.

* The proceedings have been printed by the Superintendent of the Government Press at Allahabad and will shortly be on sale.

RURAL ECONOMY IN THE BOMBAY-DECCAN—III.

By G. F. KEATINGE, I.C.S.,

Director of Agriculture, Bombay.

(Continued from page 123 *of Vol. VI, Part II.)*

VI—Live-Stock.

The live-stock of the Deccan consists of the following :—

Horses and ponies	...	...	71,000
Sheep	...	...	... 1,300,000
Goats	...	...	... 1,200,000
Buffaloes	...	...	... 500,000
Cattle	...	...	... 2,900,000

Before considering each class separately it will be desirable to give some idea of the general conditions under which stock is bred and reared in the Deccan. On the crest of the ghats, and in the strip of country adjoining, the rainfall is very heavy during the monsoon. This results in an abundance of grass; but it is coarse and of a poor feeding value; while, in this tract, the climate during the three months of excessive rain is prejudicial to the health of stock. The East Deccan is a dry country and grazing is very scanty. All the good land is cultivated, and, though large areas are available for grazing, they consist almost exclusively of stony uplands where the soil is of the thinnest. On such lands herbage is scanty and is confined to the rainy months—July to October. In an ordinary year the cattle have to work hard to find a living on these hills after December; and from March to July the so-called grazing grounds are, for the most part, as bare as a high road. In the intermediate tract between the ghat region and the East Deccan there is a fair

rainfall, and in some localities the facilities for grazing are much better. Here and there considerable areas of occupied land lie uncultivated, and the natural herbage provides some grazing; but no attempt is made to improve or enclose them, and it is only by courtesy, that they can be called pastures. Stock, during the greater part of the year, are expected to pick up a living as best they can on the hills, in the river beds, or in weedy fields from which the crop has been harvested.

Ponies are bred principally in the Eastern Deccan. In the old days Deccan ponies had a considerable reputation, and gave the mobility for which the Mahratta armies were famous a century and a half ago. Even at the present day the Deccan ponies are extremely hardy and enduring, and do good work in tongas; but their virtues end there. They are, for the most part, under-fed and under-sized; and their appearance usually indicates that they have been worked too young. The Army Remount Department has demonstrated at Ahmednagar that, with care and expenditure, good horses can be bred in the Deccan; and private breeders are not slow to avail themselves of the services of the stallions maintained by Government in the Deccan for their use. Here and there a well-to-do landholder will make a hobby of high class horse-breeding, and occasionally breed a really good foal, and obtain a good price for him; but it is hardly business, and is not usually regarded as such. If anyone requires a good horse or pony, he knows that his best chance is to go down to Bombay and buy an imported Arab or Waler.

Goats are found in every village. The males are killed for food and the females provide milk for children. No trouble is taken with their breeding; but they are very hardy, and shift for themselves, costing practically nothing to their owners for food. Under these circumstances they may be considered as a source of profit to the latter; but in so far as the community is concerned, it may be doubted whether they do not cause more loss than gain; for they roam over the unfenced country browsing on any crop that is not strictly guarded and making tree

growth impossible in places where it would otherwise take place.

Sheep are grazed in large herds of 100 to 300, and are generally accompanied by a few goats. Many shepherds lead a migratory life, frequenting the dry uplands of the Eastern Deccan during the wet months, and afterwards bringing their flocks down to the cultivated lands, where the farmers welcome them after the crop is removed, for the sake of the manure which they provide. The sheep are kept constantly on the move, and thrive on the scanty herbage, though they do not get fat on it. No system of fattening is practised, but wethers of one year old afford lean mutton which seems to satisfy the meat-eating classes who know no better. It is probable, however, that judicious fattening would pay round the larger meat-eating centres. The wool is wretchedly poor, but the manure brings in some profit, particularly in a locality where sugar-cane and other valuable garden crops are grown.

The peculiar conditions under which the sheep industry is carried on may be gathered from the following figures supplied by a sheep owner in the east of Poona District.

Annual estimate for a flock of 100 ewes.

Profits.

	Rs.
Fee paid to owner for folding 100 sheep by night on garden land on account of manurial value, at the rate of 5 annas a night for 100 sheep, for 9 months of the fine weather	84
During the remaining three months they are folded in a yard and the manure for the period may be taken as worth Rs. 16	16
Total value of manure ...	100

	Rs.
Two shearings of wool a year worth 4 annas a sheep, or Rs. 25 per 100 ...	25
100 ewes will give 100 lambs a year, 50 male and 50 female. Allowing 20 per cent. for wastage this leaves 40 one year old wethers for the butcher at Rs. 3-4-0 each	130
40 cast ewes for the butcher at Re. 1-8 each	60
Total ...	190

Profit (abstract).

	Rs.
Manure	... 100
Wool	... 25
Sale to butcher	... 190
Total	... 315

Cost.

	Rs.
Feeding costs practically nothing but 2 annas a head grazing fee to Government	... 13
Miscellaneous	... 8
Wages of one man and one boy at Rs. 12 per mensem for the two	.. 144
Total	... 165

Net profit (Rs. 315 minus Rs. 165)=Rs. 150.

So that if the capital value of each ewe be taken at Rs. 3, the sheep owner makes 50 per cent. on his capital. If the size of the flock be 300 instead of 100, the cost of labour for herding is proportionately cheaper, and the net profit is larger. On the other hand, in the wetter localities of the West Deccan the losses from disease are greater and the profits are correspondingly less.

Cattle form by far the most important and valuable part of the live-stock of the Deccan. Taking the term Deccan as denoting the Central Division of the Bombay Presidency, the number of cattle amounts to 3½ million, of which about one-sixth are buffaloes. Of the buffaloes the large majority are milch buffaloes. Except near a few large towns the milk supply is in no sense an organised industry. In the case of these towns the milk supply is derived mainly from buffaloes ; but the Deccani buffalo is not a good milk breed, nor does the country provide the quantity or quality of fodder requisite for effective milk production. The price of good milk in towns is usually very high ; and much of the milk supplied is heavily adulterated. Much might be done to improve the supply of milk ; and no doubt there is money to be made in the business ;

but the conditions of the country make it a difficult and precarious one. In the case of a few of the better breeds of cattle, when the object is to breed good bullocks, the calf is allowed to run with the cow and the cow is not milked; but in most cases the calf is allowed to suck only one half or one quarter of the milk, according as it is a bull or a cow calf.

The importance of cattle is far smaller from the point of view of milk supply than from the point of view of draught. As regards draught the horses of this tract are of little importance. Buffaloes are used in small numbers for heavy draught, for ploughing in rice fields and in some localities as the first pair in a large team of plough animals. But it is the oxen who do almost all the ploughing and other field operations in the Deccan on which the agriculture depends. The plough cattle amount to 1,315,000 and the plough buffaloes to 55,000. A large proportion of the plough cattle, including most of the best, are imported into the Deccan from Central India,* and command high prices. Eighty years ago a good working bullock of the small local breed could be purchased for Rs. 20; even 10 or 15 years ago it could be purchased for Rs. 30; but in the last 10 years the price has doubled, and is steadily rising. A fairly good Deccani bullock now costs about Rs. 60, a half bred Khillari, Rs. 100 or more; while a good Khillari or Krishna valley bullock may fetch anything up to Rs. 300 or even Rs. 400.

The cause of the rise in price is not far to seek. Ninety years ago cultivation in the Deccan generally, and in the East Deccan in particular, was scanty, and there were large areas of good land which lay waste and grew some kind of herbage. The demand for cattle was then relatively small, and the waste lands provided grazing grounds which enabled cultivators to rear cattle sufficient to meet the demand. With the advent of more settled conditions, however, a large increase of cultivation occurred, and reduced the area of grazing grounds. This process steadily continued till towards the end of the last century; at the

* The term Central India is here used as including the Central Provinces.

present time, practically all the good land is occupied, and most of it is cultivated. During this time, as the demand for bullocks increased, large numbers were brought for sale from the extensive grazing grounds of Central India; and the result of this change in economic conditions did not at once become obvious. It was not till the famines of 1897 and 1899-1900 that the pinch was severely felt. After recovering from the famine of 1876 the cattle in the Deccan had remained fairly steady at 3,700,000 during a series of good years in the eighties, and during the early nineties rose to 4,000,000. Then came the famines of 1896-97 and 1899-1900 during each of which nearly a million cattle were lost; so that in spite of purchases from outside the number fell from over 4 millions in 1895 to less than two and a half millions in 1901, a fall of two-fifths in the aggregate, and of over half in the case of certain districts. The plough cattle which numbered 1,631,000 at their high water-mark in 1895 had lost one-third of their number by 1901, and have only made up half of this loss ten years later, their number now standing at 1,371,000. It might have been expected that cattle would pour into the Deccan from Central India to make up the deficiency; and no doubt considerable numbers did come in. But Central India also had suffered severely from famine, and though prices rose, the supply fell off. The acreage of cultivated land in the Deccan amounts to 13,635,000 acres; which gives almost exactly one pair of bullocks to 20 acres. Now it may be roughly taken that in the Deccan a pair of good bullocks can cultivate 30 acres of light soil, 20 acres of medium soil and 10 acres of heavy black soil. Assuming that the cultivated area is equally divided into these three classes the present number of plough cattle works out at almost exactly the required number, *viz.*, a pair for each 20 acres of land. There are, however, two considerations which greatly discount this apparent sufficiency of plough cattle. In the first place, a large number of them are engaged for a great part of the year working the *mhots* on the 156,000 irrigation wells, and many more are employed for most of the fair season in carting on the roads; while the 500,000 acres under irrigation demand a

higher degree of cultivation, and require more bullocks. In the second place, the assumption that the plough cattle are all efficient is far from being a fact. It may be said without fear of exaggeration that 20 per cent. of the so-called plough cattle are practically useless and that another 10 per cent. are very ineffective. It is not possible to make more than a rough estimate of the number of cattle that is necessary, but the following may give some idea of actual requirements :—

		Bullocks.
To cultivate 13½ million acres	...	1,350,000
Allowance for working wells	...	100,000
Allowance of extra bullocks for irrigated lands	...	50,000
Total good bullocks necessary	...	1,500,000

Assuming that 25 per cent. of the total number of bullocks are useless, it will need a total of 2,000,000 to give 1,500,000 effective work oxen; and this may be taken as a general indication of the number necessary. The allowance made for extra bullocks for irrigated land is very moderate; and the allowance for work on wells has been pitched very low, since most of this work is taken as being done by ordinary plough bullocks; while no extra allowance is made on the ground that many of the cattle are used for a large part of the year in carting. It will be seen that, according to this estimate the number of work cattle has never been adequate, and is now 31 per cent. short. But the estimate made may be taken as a moderate one; and as irrigation increases the number of work cattle necessary will rise. The deficiency can be remedied either by increasing the numbers or by improving the quality of the animals. In either case the question of fodder is at the root of the matter. Even during a series of good years the number was unable to rise higher than 1,650,000 bullocks, good, bad and indifferent; which was itself insufficient; and a few bad years reduced the number to 1,100,000 which is totally inadequate. To provide against such losses the storage of fodder in good years to tide the cattle over the bad years is essential. Much might be done in many parts to make better use of the existing fodder supply; but that in itself would

not suffice. The people must adapt themselves to the new conditions and realise the imperative necessity for growing fodder crops. It may be said that there is hardly any lesson that they have to learn more important than the growing, efficient storage and economical use of fodder crops.

In the case of improving the quality of the cattle, too, the question is primarily one of fodder. In many localities the supply of stored fodder is barely sufficient for the working animals, and the cows and young stock are turned out all the year to shift for themselves. The nature of the grazing grounds has already been described, but the hardy stock get along fairly well from August to February. From March onwards their state is very miserable. They rapidly lose condition, and are driven by hunger to eat almost any refuse, and even to gnaw the trees. By July they are reduced to skeletons; and when the rain commences, and the young grass begins to grow, they gorge themselves on it, and suffer severely from scouring and tympanitis. Under such conditions good bullocks cannot be reared, and it is not much use talking of careful breeding. Where the fodder supply is better, some care is taken in the matter of mating. In such cases the object is usually to provide a good bull of the Khillari breed to run with the village herd. The idea is to grade up the small Deccani breed, and to rear stock of the size and strength necessary for ploughing the stiff black soils. It is generally believed that the Deccani breed has greatly deteriorated in the past 50 years. Be that as it may, it is certain that cattle larger and stronger than the present ones are required for effective ploughing; and with rising prices and a falling supply from outside the only way that the cultivators can get them is to breed them themselves. In England over half the farm land, exclusive of mountain, consists of permanent pasture, and of the arable a large part is devoted to fodder crops. To one accustomed to this state of affairs it seems natural to suppose that the Deccan cultivator would recognise the direction in which lies his only remedy. But from time immemorial he has been accustomed to trust to the waste lands for the main support of his stock,

and he still sighs for the extensive grazing lands of the past, which have assuredly gone, never to return.

Much emphasis has been laid on the question of fodder as the prime factor in the case. It will be realised, however, that there are other considerations of importance. Three great obstacles to progress consist of the constant recurrence of contagious cattle disease, the neglect of the cultivator to castrate the young bulls that are unsuitable for breeding, and the impossibility of eliminating the unfit owing to the religious objections of Hindus to kill cattle. Losses from contagious disease are trifling as compared with losses from starvation; but from 1,000 to 10,000 deaths from the former cause are reported every year; and the real numbers are probably far greater. It is not so long since such diseases were rife in England. In 1865-66 the losses in England from rinderpest were estimated at 234,000 animals, worth from five to eight million pounds sterling. The stringent sanitary measures which are there enforced by law have completely stamped out the worst of these diseases. The nature of these measures is well known, and it will suffice to say that in the case of rinderpest the owner of diseased cattle is bound to give information, and the local authorities are bound to take prompt action. All affected animals and all animals which have been in the same stable, shed or herd or in contact with affected animals *must* be slaughtered, and other animals about which there is any suspicion may be slaughtered if the Board of Agriculture think fit. No animals may move out of an infected area, or from one part to another of an infected area. Fairs and markets are prohibited. Carcases are properly disposed of; and care is taken to prevent the importation of disease from abroad. Apart from the question of slaughtering cattle, such regulations would in India be regarded as intolerable; and it would be impossible to enforce them. But in England where they have been strictly enforced, the value to the farmer Todu the results that have been obtained is incalculable. In India essen lines of work indicated are preventive inoculation and the use of ation of diseased animals.

The neglect of the Deccani farmer to castrate all young bulls not required for breeding makes careful mating impossible in a country where all the cattle run together. The excellence of the Kankreji breed in Upper Gujarat and Kathiawar is mainly due to the fact that the breeders of those parts practise early castration. In the Deccan they do not castrate bulls till they are four years old, and the number of unsuitable young bulls which run with the herd cannot fail to have a bad effect on the breed.

A matter of more importance to the present enquiry is the case of the 25 per cent. of useless cattle of all kinds, amounting in round numbers to 900,000 beasts. These consist of worn-out old bullocks, barren cows, and beasts which from extremely stunted size, malformation, broken limbs or bad feet are useless for work purposes. In a meat-eating country all such animals would be promptly fattened off and sent to the butcher, and so become a source of profit rather than loss. But in India the demand for beef is very limited ; so most of them continue to eke out a wretched existence. In this connection it may be worth while to consider the statement which is frequently made that the slaughter of cattle is in a great measure responsible for the deficiency of work-cattle. The argument seems to be that a certain number of cattle exist, and that if you kill some the number left must of necessity be less. It ignores the nature of the cattle slaughtered, and the fact that the number of existing cattle is not a fixed quantity but, within broad limits, can be increased at will. The reasoning is in fact very similar to that which underlies the theory of the "drain of wealth" from India. Now with regard to the slaughter of cattle in the Deccan the facts are these. About 50,000 cattle are annually slaughtered in the Deccan or drawn from the Deccan for slaughter in Bombay. These consist almost exclusively of worn-out old bullocks, lame and malformed beasts and barren cows. Not 5 per cent. of those slaughtered are, or could ever, become of any use either for draught or for breeding purposes. To ascertain this all that is necessary is a visit to the slaughter-houses ; but an examination of prices will suffice

to show that this must be so. The carcass of an average Deccani bullock of the kind and condition brought to the slaughter-house, skinned and dressed, weighs about 150 lbs. which at the current rate of 12 lbs. per rupee is worth Rs. 12-8-0. The hide is worth Rs. 6 and the offal and fat (say) Re. 1-8-0. Total Rs. 20. But between the cultivator and the meat seller are several middlemen who have to make their profit, and recoup the cost of bringing the animal to market. The cultivator will be lucky if he gets Rs. 15 for the bullock. Now it has already been stated that the price of a good Deccani bullock is Rs. 50 to 60; and it may be confidently stated that there is not a bullock of any use for draught that would not command at least Rs. 30. Is a cultivator likely to sell to a butcher for Rs. 15 a bullock which will command Rs. 30 or more in the market? He certainly will not do so; and if he sells a bullock for Rs. 15 or less, the reason is that it is useless for draught purposes, and its only value is for slaughter. The same argument applies to a bullock of larger breed, with a dead weight of 300 lbs.; all that is necessary is to double the figures, and it will in the same way be realised that a cultivator will not sell to a butcher for Rs. 30 a bullock for which he could get Rs. 60 or more for draught purposes. So far as bullocks are concerned, a consideration of the price of beef and the price of draught animals will show that a draught animal is worth far more alive than dead. Under such circumstances it is only the unfit and the worn-out that are brought for slaughter. Occasionally a calf may be seen at the slaughter-house which looks as though it would with proper attention turn into a fair bullock and one wonders why the cultivator has sold it. It is pretty certain, however, that the original owner knew more about the calf than the casual observer does, and he also knew what facilities he had for rearing the calf to maturity. If he found it more profitable to sell it for Rs. 10 when it was young and in fair condition, he probably knew what he was about. Barren cows provide the best beef; and are often young and in good condition when brought for slaughter. They are of course useless for any other purpose.

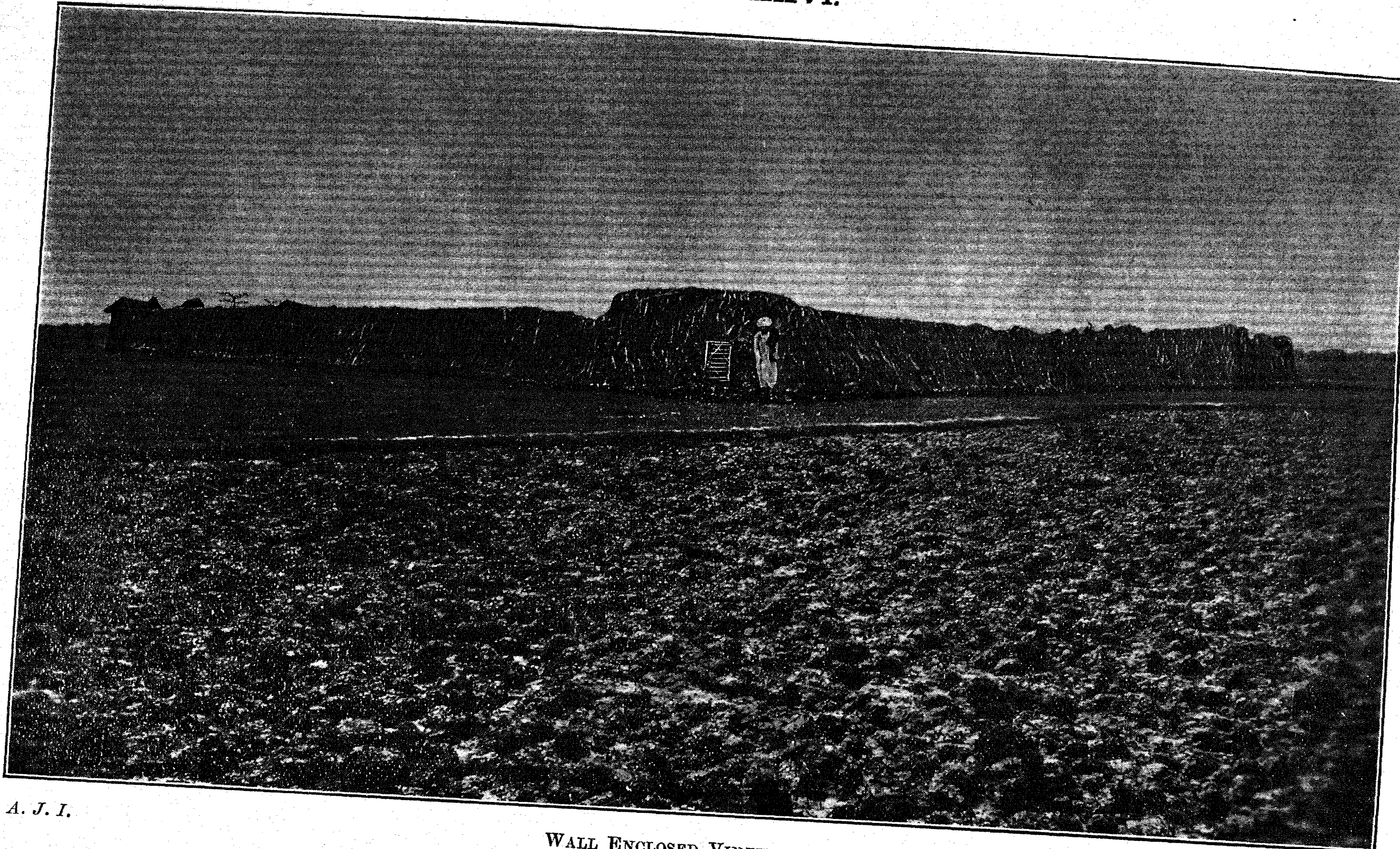
The number of cows wholly or partially barren to be seen round the country side is very remarkable. Anyone accustomed to the circumstances of economic cattle-farming expects to see every cow earning her living. She should be in milk, or in calf, or fattening. But in the Deccan numbers of cows are to be seen doing nothing to pay their way. Many are completely barren, and many others calve only once in two or three years, and give but little milk, and that for a short time only. This is partly a matter of personal idiosyncrasy, and partly due to lack of green fodder without which cows will not come in season. In some cases a little work would probably put the cows right; but this is contrary to Hindu custom. In France and Belgium small holders habitually work the cows. They generally cannot afford to keep bullocks, and in such cases the cows have to do all the cultivation. Far from being bad for the cows, light work is beneficial to their health even when they are in milk. They must, of course, not be given very heavy work or be put to a severe strain; but when carefully treated by the owner they do useful work without any harm to themselves; and in this way they are of the greatest assistance to small holders.

It will be realised from the above that it is not the 50,000 Deccani cattle which are slaughtered annually which cause loss to the cultivator, but the 800,000 useless beasts who are not slaughtered. If there was a greater demand for beef and the cultivator could dispose of them all for slaughter even at Rs. 10 a piece, the Deccan would be Rs. 80 lakhs better off, and there would be more grass for the effective cattle to eat.

In stating the economic facts with regard to the slaughter of animals, it must not be supposed that it is intended to recommend to Hindus that they should countenance the slaughter of cattle. It would be obviously improper and foolish to advise them to do what is repugnant to their religion and to their feelings. It is essential, however, to realise the facts. In India the provision and maintenance of cattle are a source of difficulty and loss to the cultivator, while in other countries the cattle are a source of profit. Leaving on one side England, where cattle are

not used for draught, and looking at France over a large part of which cattle do most of the farm work, it is found to pay to slaughter bullocks not only when they are getting old, but long before they are worn out. Bullocks are commonly worked from 4 to 7 years old, and then fattened off. Fine bullocks of the large white Charolais breed may be seen going off to the butcher at the age of 7. It is simply a question of what pays best; and it is by such methods that cattle which used to be regarded as a "necessary evil" to the French farmer are now converted into a source of profit. The French farmer sells off his seven years old bullock to the butcher knowing that he has more young ones coming on. He takes three years work out of them and converts them into cash before they begin to deteriorate. It is not likely that the demand for beef in India will increase to a point at which the flesh of all useless animals would find a market; and it is, therefore, most improbable that the price of beef will rise to a point at which it would pay to slaughter animals which are of any value for draught or for breeding. The above facts are, however, mentioned to show that even if such a thing were to occur, it would not necessarily be prejudicial to agriculture. Far from it; it would solve the greatest difficulty of the cultivator, and enable him to do what the French farmer has done, *viz.*, to make the meat consumer pay for the ploughing of his lands.

(*To be continued.*)



A. J. I.

WALL ENCLOSED VINEYARD.

GRAPE-GROWING AROUND PESHAWAR.

By W. ROBERTSON BROWN,

Superintendent of Farms, N.-W. F. Province.

THE grape vine is vigorous and fruitful throughout the greater part of the North-West Frontier Province. A grape *pergola* is generally to be found in the public garden of each district and the shade tree by the well of the zamindar is often vine-embowered. But vineyards in the true sense of the word are chiefly clustered around villages which have grown grapes for the Peshawar market for at least half a century. The villages of Ahmad Khel, Bazid Khel, Sheikh Mohammadi, Suleman Khel, and a few others in the Peshawar tahsil, which are situated within eight miles of Peshawar city, have long been noted for the productiveness of their vineyards and the quality of their grapes.

The village of Sheikh Mohammadi has 400 vineyards; Suleman Khel has 100; Mashu Khel has 150; Bad Ber has probably 100, and other villages in the same tahsil have each from 20 to 100 vineyards enclosed by walls and ranging from one quarter to two acres in extent. Each of these villages markets many hundreds of maunds of grapes in the months of July and August. Plate XXVI shows the unpicturesque walls of a typical vineyard. The stalwart Mohmand viticulturist creeps in and out by the little wicker gate which is 4 feet high by 2 feet wide.

Climate and Soil.—The temperature within the walled-in vineyards throughout the year has not yet been recorded, but in July and August, with the faintest breeze shut out, the atmosphere in the vineyard is stifling. Even under the dense canopy of foliage the temperature is probably not less than 130° at noon. In December and January it ranges from 22° to 80.° In average

years heavy showers of rain fall in February, and again in late March or early April. Then follow two or three months of fierce unbroken sunshine, during which time the vineyards are freely irrigated. These are exactly the conditions under which superb European hot-house grapes are produced. The vineries there are sprayed freely while the young shoots are extending, but after the berries are set, spraying is discontinued as it would blemish the berries. The land around the grape-growing villages is renowned in the North-West Frontier Province for its fertility. It is deep red alluvial loam and is fertilised by the heavy deposits of muddy silt which the water of the Bara leaves after every turn of irrigation.

Drainage and Irrigation.—The vineyards have excellent natural drainage, and around the villages the land is levelled for irrigation on contour lines, scarcely two fields being on the same level. The Bara water rises and falls rapidly. Its bed is not infrequently almost dry for a considerable time and then the vineyards, in common with field crops, suffer from drought. As far as possible, the vine growers irrigate every tenth day between 15th April and 15th June. After the crop is gathered, irrigation in moderation is renewed till early December, after which the vines are given three months' rest. The high mud-walls serve to protect the vineyards from scorching winds, from grazing animals and other depredators. Thefts by the villagers are rare, for the owners of the vineyards give generously, and the poorest can afford to buy a few peaches or grapes in the season in July or August.

Preparation of the Land and Planting.—After the protective walls are built in December, the land is ploughed as frequently as possible before the 15th January. In early February wide shallow irrigation channels are dug out at 15 feet from centre to centre and usually 4 feet wide by one foot in depth. Cuttings—not rooted nursery plants—are planted. Sites are marked down the middle of each irrigation channel, and four stout vine cuttings, 1 foot of which is buried, are set at each site. One foot of cane is buried. When planting is finished, the groups of cuttings are in squares which are exactly 15 feet

apart every way. White ants invariably eat one or two of the cuttings, and it is on this account that four cuttings are planted. Two plants only are desired at each site. In the first year brinjals, or other summer vegetables, are grown between the newly planted vines, and the shoots from the cuttings are permitted to ramble at will over the catch crops.

First Pruning.—In February, almost exactly twelve months after the date of planting, the first pruning and shaping of the vines begin. Strong canes are *slightly* cut back ; weaker canes are more severely shortened. In each cane the laterals (shoots from the leading canes) are cut back to one or two buds from their bases. When the vineyard has been dug over by the spade, light twiggy branches, like pea sticks, and about 2 feet to 3 feet in height, are stuck irregularly over the land, and chiefly around the plants. Over these the young shoots of the year are allowed to grow unchecked. By the 15th of June, when the plants are 16 months of age, the vineyard presents a broad level spread of luxuriant deep green foliage. Each vine is now vigorous and in unchecked state of growth.

Second Pruning.—Next year second pruning and the cropping begin. Most of the work of cultivation in the vineyards is done in February. At that time the vines are pruned and the land is turned over by the spade. Pruning in the first and second years is light work. In the third year the tangled masses of shoots are cut back to the main rods. Each vine has from three to five *arras* or rods of 8 to 12 feet in length. The laterals on the rods are pruned annually to within half an inch of their bases. The pruning given in this, the third year, is exactly that which is practised throughout the lives of the vines. Grapes are borne on shoots of the current year only. The vigour of the vines is by the pruning confined to comparatively few shoots, and these are in consequence strong and capable of maturing good bunches of grapes. The *datrie*, a small saw toothed sickle, is used as a pruning knife. European gardeners would recoil from this barbarous treatment. The real work of training the vines begins after the second pruning. A rough framework

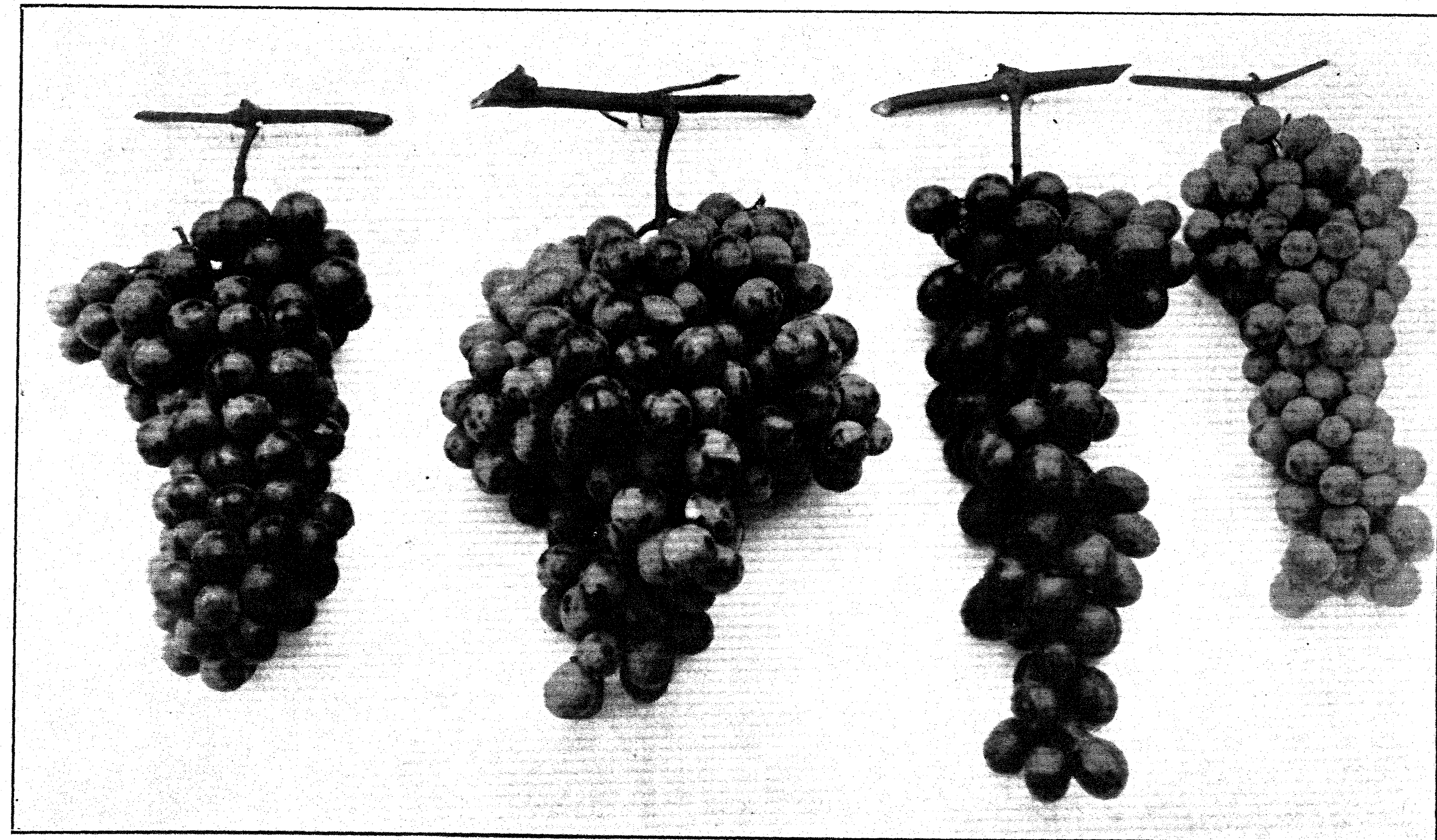
of any available branches is erected over the vineyard at about $2\frac{1}{2}$ to 3 feet from the ground. The bare pruned canes are spread over and lightly tied to the frame. That completed, the vine grower can rest till his crop is ripe. The young shoots which spring from the pruned canes are not summer pinched or checked in any way. They grow widely in every direction.

Cropping.—A few bunches of grapes are carried by the vines in their third year; but full crops are borne from the 7th year. There is a fruitful vineyard at Bazid Khel which has carried good crops of grapes for over 50 years. The Peshawar tahsil vineyards are mostly of mature age. The number of bunches per vine is not regulated. Every bunch is permitted to remain; nor are the berries in the bunches ever thinned. Under this inconsiderate treatment the weight of crop per vine varies annually. Some vines carry thirty bunches, others carry over one hundred.

Varieties.—Seven distinct varieties are grown and the oldest villagers say that all of these were in the old vineyards of their forefathers. The varieties are described on page 225 from a grower's point of view. (Plates XXVIII & XXIX.)

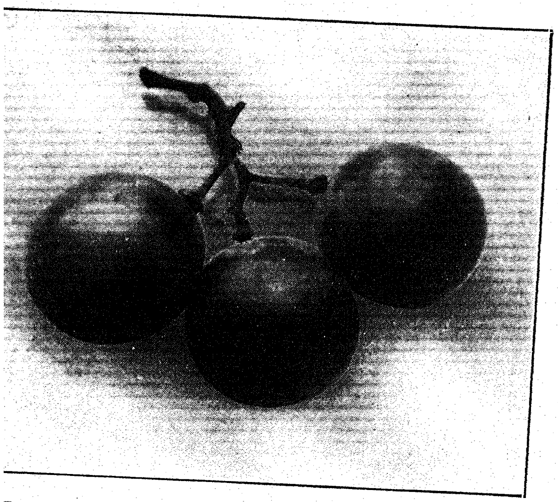
Harvesting and Marketing. In gathering fruits the labourers have to crawl on hands and knees. It is trying labour, and a boy from a grape growing village would not willingly gather grapes between 9 A.M. and 6 P.M. The grape growers commonly lease the crops of their vineyards to Peshawar fruit agents for periods ranging from two to ten years. The owners cultivate the vineyard, dig, prune, and weed; they maintain the vineyard walls and they pay the land revenue. When the crops are ripe, the agents take over charge, and market the grapes. The sum received by the growers per half acre—*jarib*—varies considerably. If a vineyard has a good proportion of vigorous vines of kismis, bedana or sursavai, Rs. 400 may be realised. Rs. 200 per *jarib* per annum is considered a poor price. The villages in the Peshawar tahsil have an unusually amiable and convenient arrangement for the supply of the Peshawar market. Each village or pair of villages has two allotted market days per week.

PLATE XXVII.



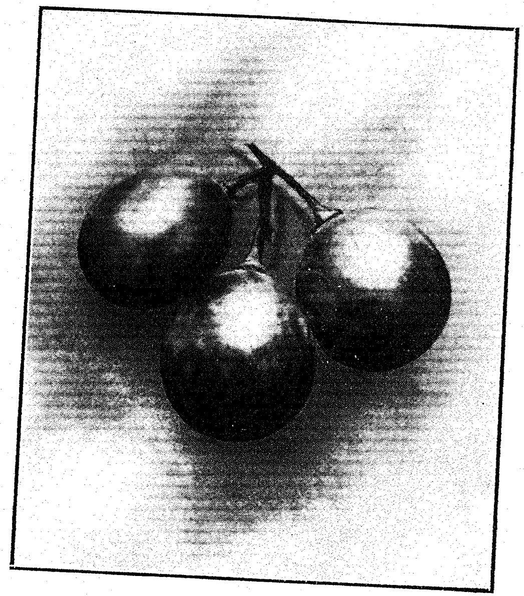
A. J. I. (*a*) Tur. (*b*) Tas.

PLATE XXVIII.



I.

TUR.



TAS.

KISHMISHI.

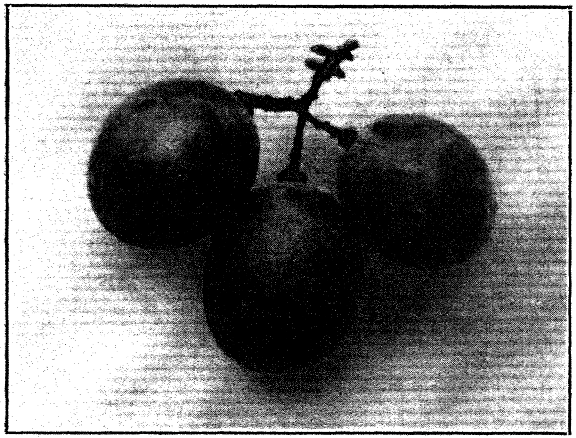
Peshawar Grapes in their order of ripening.

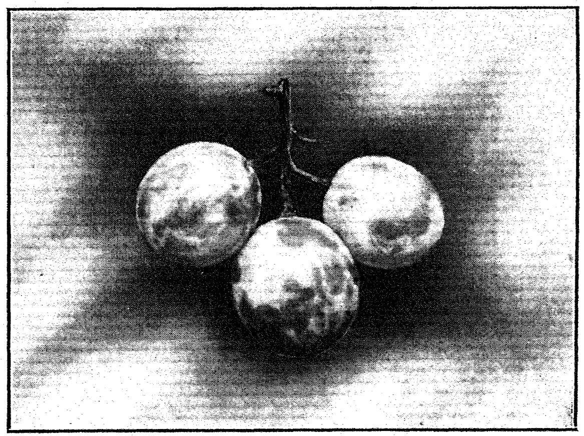
Variety.	Vine.	Leaves.	BUNCHES. Size.	BUNCHES. Shape.	BUNCHES. Setting.	BERRIES. Colour.	BERRIES. Shape and size.	BERRIES. Skin and flesh.	BERRIES. Flavour.	Cropping.	Price per maund.
											Rs. Rs.
1. *Tor* ...	Vigorous ...	Large and thick.	Medium, 3 lbs. large.	Shouldered	Excellent. .	Black ...	Round medium.	Thick, fairly firm.	Good ...	Very heavy	3 to 8
2. *Kismis* ...	Weak ...	Small and thin.	Small, 3 lbs. large.	Without shoulders.	Very poor	White ...	Roundly oval, small.	Very thin, fairly firm.	Very good, excellent.	Very light	10 to 25
3. *Tas* ...	Vigorous ...	Large and thick.	Very large, 5 lbs. large.	Shouldered	Excellent...	Greenish white.	Round medium.	Very thick, very firm.	Poor ...	Fair ...	2 to 10
4. *Sarsaini*...	Do. ...	Medium ...	Medium, 4 lbs. large.	Without shoulders.	Good ...	Reddish purple.	Oval, large	Medium, watery.	Excellent...	Heavy ...	3 to 8
5. *Bedana* ...	Weak ...	Small, thin and round.	Small, 1 lb. large.	Do.	Do. ...	White ...	Round medium.	Thin, firm and seedless.	Do. ...	Light ...	5 to 20
6. *Joshi* ...	Do. ...	Large and thin.	Small, 1½ lbs. large.	Do.	Moderate...	Do. ...	Do. ...	Thin, fairly firm.	Fair ...	Poor ...	2 to 8
7. *Hussaini*...	Moderate...	Medium, thin and yellowish.	Medium, 1 lb. large.	Do.	Do. ...	Do. ...	Oval, large	Thick, watery.	Do. ...	Light ...	6 to 10

One may market on Monday and Thursday; the other on Tuesday and Friday, and so on. In this way village inter-competition is avoided, and the market is less likely to be glutted. The fruit is cut in the evening, and piled lightly on large open flat baskets which carry from 20 seers to 1 maund. Scarce or delicate kinds, such as kismis or bedana, are marketed in baskets which carry 20 seers or less. The fruit is conveyed to the city market on flat hand-carts drawn by two stout men. Round cockle-shell shaped baskets are used in conveying grapes by rail to the more important cities and towns of Northern India. The baskets are lined with soft dry grass and a few vine leaves, and when packed weigh 10 seers. The bunches are evenly and firmly packed and convex lids are laced securely down Railing is entirely in the hands of the fruit agents. They book orders and arrange for supply.

Diseases and Insect Pests.—The pests of the vineyards of the North-West Frontier Province have not yet been studied, but it may safely be said that most of the troubles which affect European or American grape vines trouble the grapes of the North-West Frontier Province to some extent. Phylloxera is happily not known. Mildews are common; there are few large bunches of grapes which have not a proportion of "shanked" berries—or "scalded" or "rusted" berries. Red spider spreads every autumn. Thrips and aphides are not serious pests.

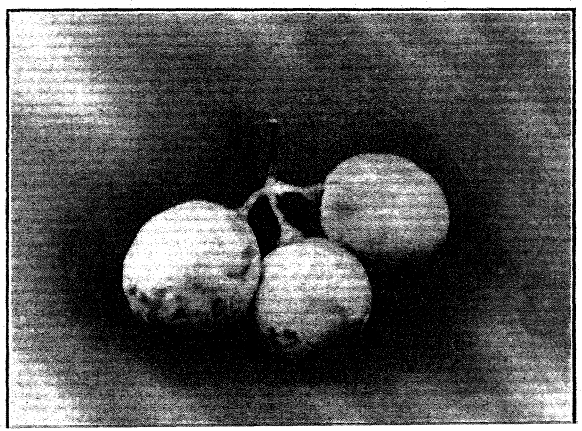
PLATE XXIX.

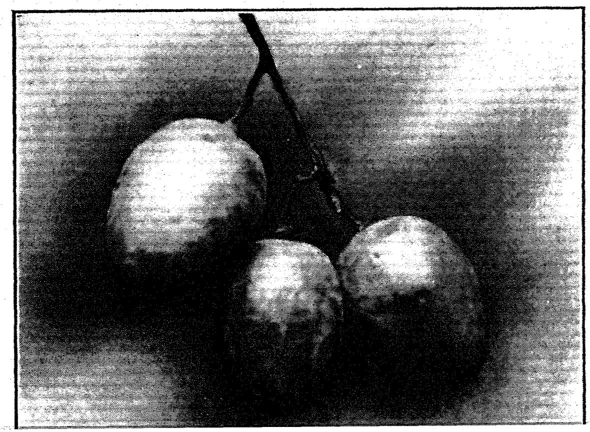


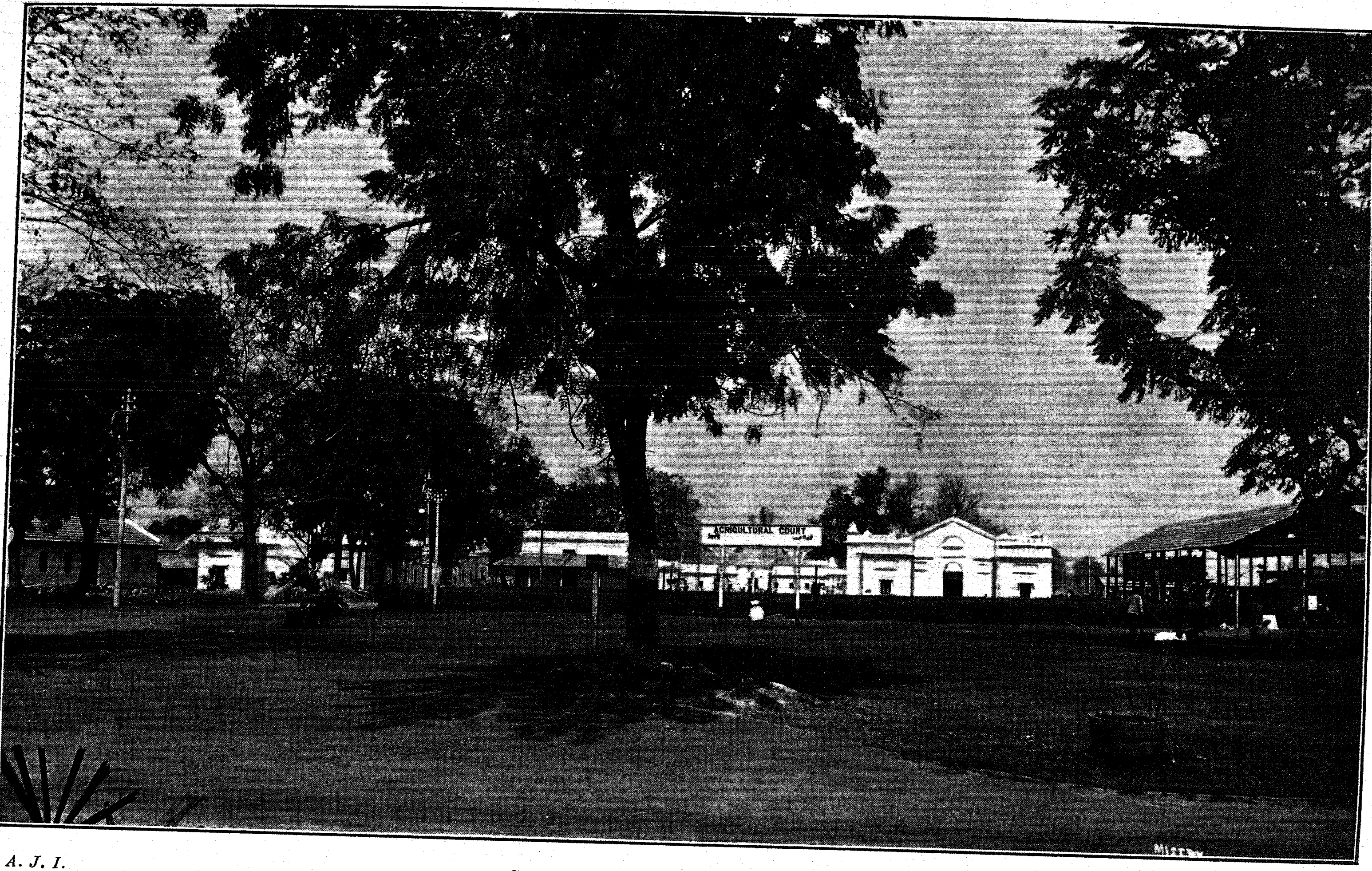


SURSAVAI.

BEDANA.







A. J. I.

GENERAL VIEW, AGRICULTURAL COURT.

THE AGRICULTURAL SECTION AT THE ALLAHABAD EXHIBITION, 1911.

I.—MACHINERY AND IMPLEMENTS.

By S. MILLIGAN, M.A., B.SC.,

Deputy Director of Agriculture, Punjab.

This section of the exhibition has been the subject of many laudatory reviews, and, on the other hand, of not a little adverse criticism, the main objection offered being that many of the exhibits were unsuited for use in India. This somewhat narrow view of the subject neglects the acknowledged educative value of exhibitions generally, and more especially in India, where the public have few opportunities of seeing what is being done in the outside world. To those interested in the agricultural development of this country the agricultural machinery section contained much of interest, and not a little of immediate practical value.

As it is quite impossible in a short article to deal with the whole exhibit in this section, it is proposed to refer briefly to a few of the more important classes, more especially with regard to their suitability to the conditions of Northern India.

The more obvious features of the Exhibition have been so fully described elsewhere that little remains to be added. Suffice it to say that the site was ideally chosen on the banks of the Jumna—the buildings were commodious and sufficient, and that the general arrangements left nothing to be desired (Plate XXX). A feature of the agricultural machinery section lay in the facilities for practical trials of tillage implements and such machinery as threshers, winnowers, mowers and reapers, provided

for by the Exhibition authorities; and although the available space was necessarily limited, these trials were of great assistance to the judging committee and of interest to visitors generally.

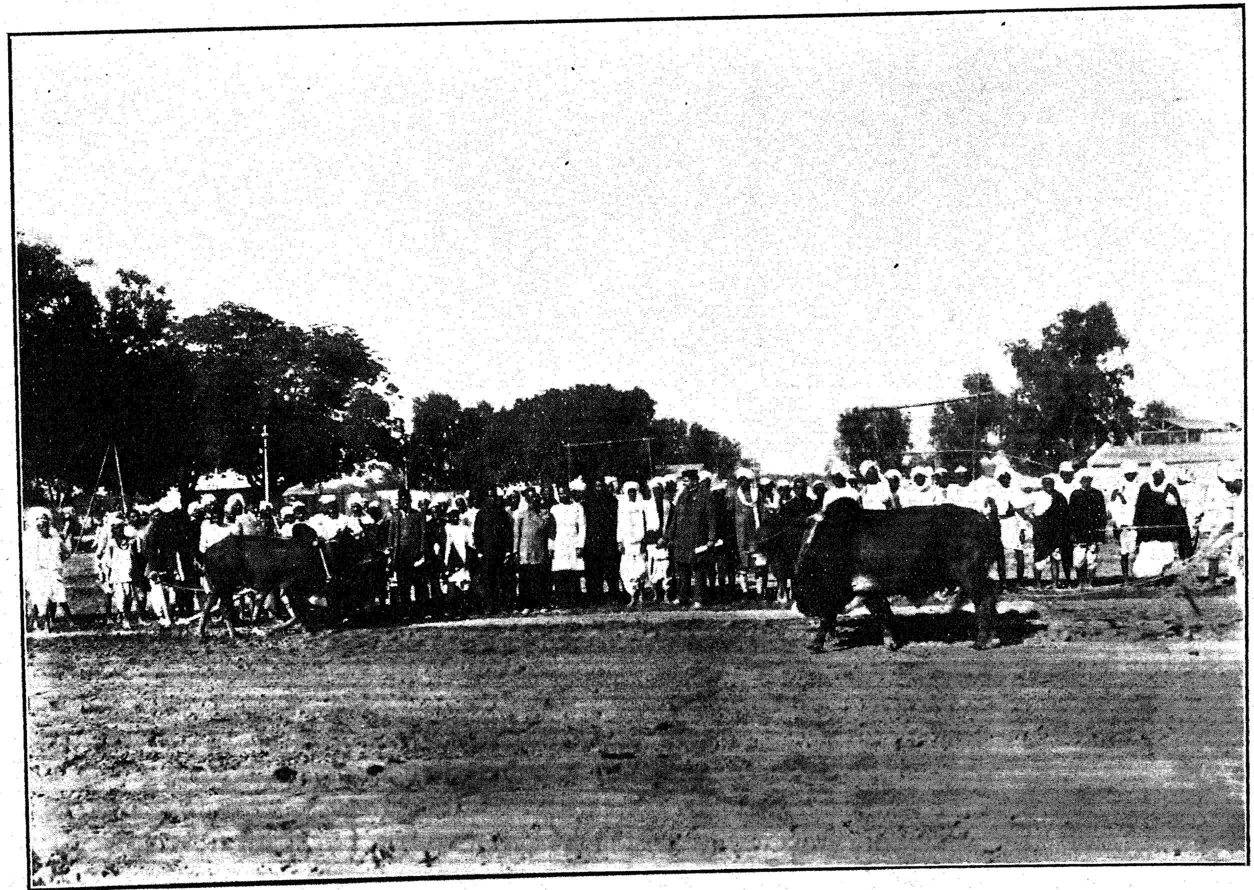
Tillage Implements.—In any country implements for tillage are of first class importance, and this is more especially the case in India. Experiments conducted by the Agricultural Departments have shown the great possibilities of increasing the yield of crops by improved methods. It is almost certain that this will only be brought about by improved implements, as the *rayat* has probably reached his limits with his present stock in trade. Dealing first with ploughs, it may be stated that this section showed great variety and was on the whole representative of the modern plough (Plate XXXI). For the sake of awarding prizes the exhibits were divided into three sections—heavy, medium and light.

Heavy Ploughs.—In the heavy class, which included gang ploughs of both the disc and mould-board patterns, the most interesting feature was, perhaps, the trial of a single reversible disc plough, shown by Ransome, Sims and Jefferies, Ipswich, which made short work of some stiff land with a fairly hard crust near the pumping station and suggested possibilities for dry land cultivation. Other exhibits in this class consisted of lea, stubble and furrowing ploughs, which though good in themselves presented no new departures in design.

Medium Weight Ploughs.—In this class there was a large number of exhibits and the majority of the ploughs were included in it. On trial very satisfactory work was performed by ploughs exhibited by John Wallace and Sons, Glasgow; and Ransome, Sims and Jefferies. These two ploughs, which are of the same pattern, finally shared premier honours and were awarded gold medals. The pattern is very suitable for medium cultivation, cleaning out perennial weeds and, if properly used, for ploughing in green crops for manure.

Light Ploughs.—This class was meant to include all small ploughs costing under Rs. 10 to be used for general purposes as a substitute for native ploughs. Although exhibits were

PLATE XXXI.



PLOUGHING: AGRICULTURAL COURT.

plentiful, they all belonged to the two types of plough well known in India as the "Watts" and "Meston" patterns. On trial the Watts had no difficulty in defeating its rival the Meston, and the final award went to Ransome, Sims and Jefferies for a well-finished specimen of the former, which, considering that the share and other parts are made of chilled steel, should be good value for the money. Summarising, it may be stated that each class of the plough section produced one or two ploughs of considerable utility for special purposes in India.

Harrows and Cultivators.—This section was none too good, considering its importance. There was a distinct want of variety in the exhibits, and with the possible exception of spring toothed harrows there seemed to be little of value for Indian requirements. Messrs. Ransome, Sims and Jefferies, it is true, showed a spring tined cultivator of great finish and quality, and one could only regret that it was too good for the country.

Intercultivating Implements.—In this class may be grouped both hand and bullock or horse-hoes and harrows. The exhibits were of the pattern generally adopted now-a-days with multiple adjustments and presented no new features. This is an important class of implements for India, where intercultivation is so necessary to preserve moisture and keep the soil in proper condition during the early stages of the growth of the crops.

What is wanted for India in this class is more good patterns than first class workmanship. Soil conditions are, compared with most other countries, very easy, and it is not advisable for the cultivator to put his money into getting too high a finish in his implement. Harrows, cultivators and drill hoes, etc., can be, however, readily and cheaply made in the country—all that is necessary being correct patterns. It is hoped that the best types, shown at the Allahabad Exhibition, will supply this.

Harvesting Machinery.—Next in importance to tillage implements comes harvesting machinery. There is little doubt but that the prolongation of the wheat harvesting season affects the whole system of agriculture in the Punjab and parts of the United

Provinces, and severely handicaps any attempt to improve on present practices. It should, therefore, be remembered that the adoption of improved harvesting processes in addition to any direct benefits, would undoubtedly have a powerful indirect effect on the agriculture of these Provinces. To secure the introduction of machinery for this purpose, however, it must pay its own way initially, as the people are not at all inclined to look to indirect advantages.

Reapers and Mowers.—This class in the exhibition was of interest mainly on account of the fact that the scarcity of harvest labour in the Punjab has made reapers a very profitable investment on land where they can be used. In the greater part of Northern India their extended use is under present conditions out of the question. The number of exhibits were few. The gold medal was awarded to John Wallace and Sons for the type of machine which has been used in the Punjab for three years, and is an adapted mowing machine with manual delivery. The second prize went to the International Harvesting Co. for a McCormick side delivery machine.

Threshing Machines.—The necessity of improved threshing machinery for wheat is becoming more evident every year, and although many efforts have been made to solve the question, little headway has been made. It is hoped that the attention drawn to the subject by the Exhibition will have the effect of promoting the movement. The difficulty is entirely one of *Economics*, as the machines shown at Allahabad on the whole performed their work very satisfactorily. The crux of the question lies in recovering interest and depreciation charges on an expensive plant in the short season during which it can be used. The deciding factor in this class of machinery is thus the ratio of the output to capital cost. Hence, other things being equal, reliability and that which comes to the same thing in India, simplicity of design, are essential. In the Exhibition chief interest was, of course, centred in the steam threshing plants, which for a considerable time gave working demonstrations daily.

Steam Threshers.—Three English firms came forward with exhibits. Marshall Sons & Co. and Garretts with one plant each, while Ransome, Sims and Jefferies showed two of different designs. All machines were of the latest patterns approved by their makers, and there was really little to choose in the work done by them, which, as mentioned above, was quite satisfactory. All machines were fitted with straw bruising and chopping apparatus. At the same time it must be admitted that for ordinary purposes in this country three of the machines were of a type which presented too many complications. The fourth, shown by Ransome, Sims and Jefferies, a 30-inch machine driven by a 3 h.p. portable engine, came much nearer to what is required for the country. The machine in question, by effecting the chopping in the threshing drum, is thereby so much simplified that it presents the appearance of a large open sifter with two cylinders. Weight is also considerably reduced and the set, each part of which (the engine and thresher) weighs only 3 tons is quite portable even on district roads.

Bullock Power Threshers.—It was a pity that the machines exhibited in this class could not be shown working. There is little doubt but that a really satisfactory machine for bullock-power would command an immediate market. Both Messrs. McCartney, Old Cumnock, and the Bon Accord Co., Aberdeen, exhibited useful looking machines, but it is impossible to estimate their worth without trial. None of the exhibits had straw chopping and bruising attachments. It is a pity that no attempt had been made to exhibit anything in this line, as there is only one season for *bhusa* making in Northern India and the operation must be done at harvest time, when the straw is dry and brittle.

Hand Power Threshers.—A few firms exhibited hand power threshers. Owing to the strain required to keep up speed there does not seem much opening for this class at present. A machine shown by Messrs. Hunt, which did good work on trial, might probably with advantage be driven by cattle.

Winnowing Machines.—The people in Northern India depend entirely on the wind for winnowing purposes, and

although the dry climate is favourable for all harvesting operations, much time is lost in localities where wind is uncertain. Until steam threshing is successfully introduced, if it ever is, into these places, a winnowing machine for the threshed wheat crop is needed. This section in the Exhibition was, therefore, an important one, and although most machines shown were of the grain-dressing type, there were a few exhibits, which represented attempts to produce machines for Indian requirements. A machine exhibited through the Central Provinces Agricultural Department, manufactured in the country, deserves some mention. Made entirely of iron, it should be fit to stand any climate. The mixture of chaff and grain is shaken transversely over a rough riddle with a considerable slope, and provided the straw in the mixture is not too long, the machine does satisfactory work.

An entirely different type, built by John Wallace and Sons, for the longer and rougher *bhusa* of the Punjab, has long smooth perforated zinc riddles, a horizontal shake, and a blast divider. The whole machine is built to avoid choking and to give a large daily outturn. Its work was considered so good that a gold medal was awarded to the maker. Other machines, as stated above, were practically grain-dressers and though good in themselves, had little capacity for dealing with *bhusa*.

Having dealt with tillage implements and harvesting machinery, which are the main stock-in-trade of farmers all the world over, and of which the largest portion of the agricultural machinery of the Exhibition consisted, there remain many additional features well worthy of mention.

Fibre-extracting Machinery.—Fibre-extracting machinery comes more under the head of Industry than Agriculture, but it is impossible not to note the excellence of the exhibits in this section. Special mention must be made of the decorticating machinery of Messrs. Krupp and Co., which specially commended itself to the judging committee after extended trials, and was one of the most attractive sights in the exhibition.

PLATE XXXII.

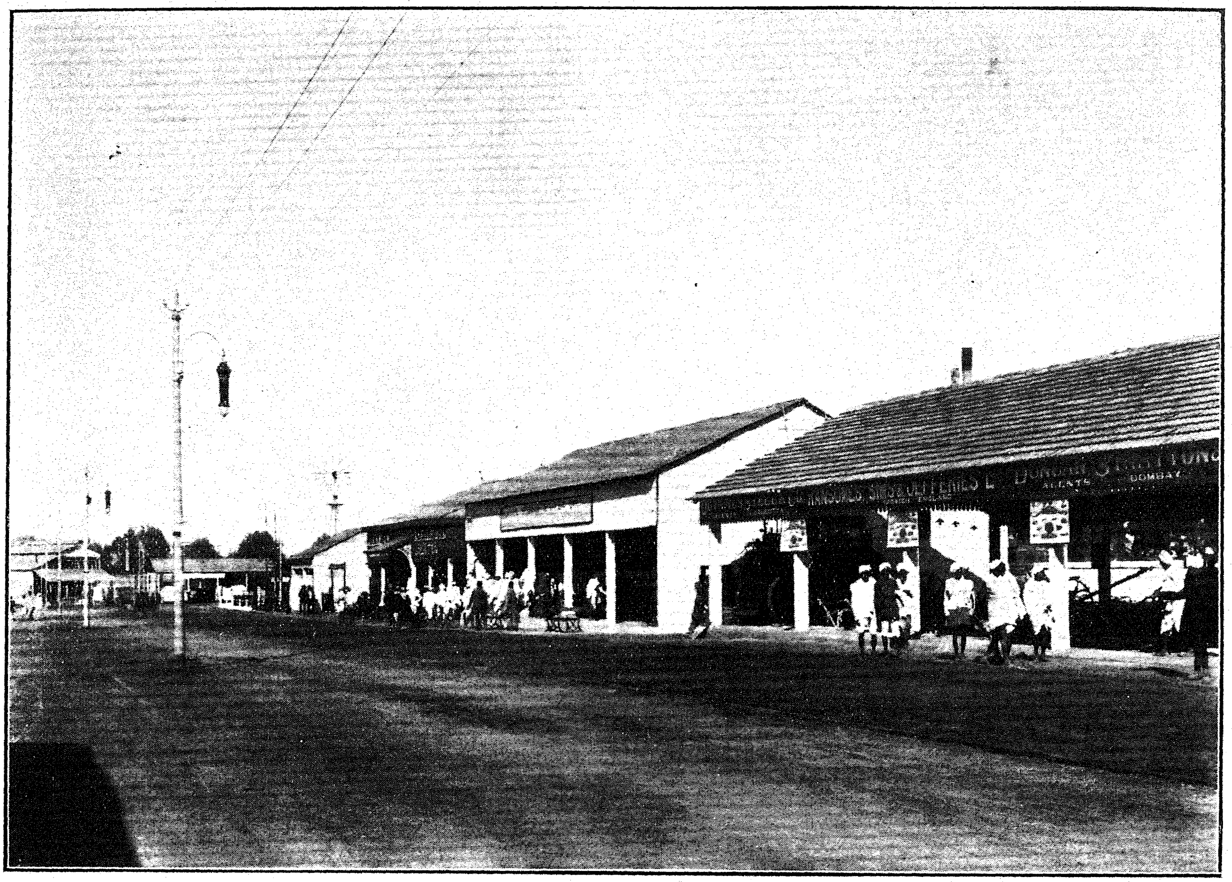
A. J. I.

MACHINERY SHEDS, AGRICULTURAL COURT.

Bullock Power Cane Crushing Mills.—It is with real pleasure that we have to refer to the excellent exhibit of the Nahan Foundry in this section. This well-known factory, owned by the Nahan State (Ambala Dist.), has probably done more for sugar-cane growers in the Punjab by the great efficiency of its cane mills than any firm in existence. They exhibited a complete set of their standard pattern mills, which were models of good workmanship and careful adjustment.

Dairy Machinery.—The Dairy Industry in India is assuming an increasing importance, owing to the industrial development of the country and the demand for a better class of produce from the large towns. Although exhibitors of this class of machinery were few, the deficiency was more than made up by the completeness of the working dairy shown by the Dairy Supply Co. in conjunction with Mr. Keventer of Aligarh. The plant was thoroughly modern, driven by electricity and was the centre of much interest.

Space does not permit of mention of many other interesting features in the Agricultural Court. Such exhibits as fodder presses, flour mills, rice-husking machinery, all of which are of direct and indirect importance to a rural community, have not been dealt with. The necessity of explanatory remarks in an article of this nature necessarily limits the number of classes which can be discussed and also any detailed mention of the names of the exhibitors. The excellent general displays in the stalls of firms like Burn, Marshall, Ransome, Sims and Jefferies, Rudolph Sack, Krupp, Thomson, Leslie, The Empire Engineering Co., the International Harvesting Co., and many others can only be mentioned (Plate XXXII). After all that has been said of the excellence of the organisation of the Exhibition, it was the enterprise of the exhibitors which made it the undoubted success it was.



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II.—WATER-LIFTS.

By ALFRED CHATTERTON, B.Sc.,

Superintendent of Industrial Education, Madras.

In the report of the Irrigation Commission, which for statistical purposes is now perhaps a little out of date, it is stated that in the United Provinces there are 500,000 permanent wells and 830,000 temporary wells irrigating in a normal year 5,731,000 acres. The average lift is probably not less than 30 feet and in the aggregate the amount of work done by cattle power in lifting the water for the irrigation of this vast area is enormous and the cost to the ryots of the country an annual sum which may be more than, but certainly cannot be far short of, 10 crores of rupees. This is not all, as besides the area under wells, there is much irrigation under canals, *jheels* and swamps which involves lifting the water. It is true that the lift in these cases is seldom more than a few feet, but most of the work is done by hand and human labour is invariably more expensive than cattle power.

I do not pretend to any great accuracy in the above statements, which are only made to illustrate the importance of water-lifting in these Provinces and the necessity for carrying out such work in the most economical manner possible. That it is not so done goes without saying, but the extent to which improvement is possible is quite unknown. It is a matter for the State to deal with as the problem is far too difficult for private individuals to tackle, and there is but little chance that any adequate solution would yield a direct pecuniary reward to the individuals who

worked it out. It is mainly a question of adapting the means available under modern conditions to the end required, which is the lifting of small volumes of water through a moderate vertical distance. If the volumes were larger or the vertical range greater, the problem would be a simpler one. The real element of difficulty is to apply mechanical methods of lifting water to the small scale on which the ryot works.

I am not sufficiently acquainted with the ryots' methods of lifting water in the North of India to express any opinion on the possibility of improving them, but in respect to the South of India I feel fairly confident in saying that the best practice of the ryots in their methods of applying animal or human power to lifting water is, if not perfect, exceedingly hard to improve upon. The *picottah* is a very efficient water-lift for heights ranging between 10 and 20 feet, and though at first sight it may seem that to employ one man solely to tilt the bucket and guide the lifting rod is a waste of energy, yet it is not really so, as by changing round from time to time each man gets a needed rest and the work goes on without exhausting the men for a longer time than would otherwise be the case. Similarly the South Indian *mhote* with its leather or iron bucket and leather discharge pipe is, when worked on a steep incline on the *Kili* system, an excellent method of utilizing cattle to draw water from a deep well. It of course involves the employment of two pairs of cattle and is not well adapted to shallow wells from which water may be drawn by the *mhote* worked on the *lagor* plan with one pair of cattle. Various attempts have been made to improve on these methods and some of them have had a certain amount of vogue for a time, but they have gone out of use and must therefore be classed as failures. The indigenous methods are the result of long experience and are probably an example of the law of the survival of the fittest—that is, of the methods of drawing water from wells which are most suited to the environment and resources of the ryots. Experience has taught the people of India that, to get the most work out of men or animals, they must not apply their muscular efforts to the direct production of

external work, but that they must, as far as possible, store kinetic energy in their bodies, and utilize the same by allowing their weight to act by the descent of their bodies. The *picottah* has a high efficiency because this principle is very perfectly carried out in that water-lift and the single *mhote* has easily held its own against the double *mhote*, partly because of its simple character, but mainly because whilst descending a steep incline, the gradient of which is from 1 in $2\frac{1}{2}$ to 1 in 3, the animals automatically throw a very considerable proportion of their weight on to the yoke and thus are able to exert a much stronger draught than when walking on the level and therefore draw up a much larger bucket of water each time. Again, an animal like a bullock and still more a pair of them are able to exert a much stronger draught in a straight line than when walking in a circle. To attach a pair of animals to a gin or whim such as is very commonly used is to employ their muscular efforts in the most inefficient way possible. The smaller the diameter of the circular path in which they walk, the worse is the result. No ingenuity in the design of the water-lift worked in this way can altogether compensate for the defects in this system of employing power. In some instances, such as the common mortar mill, the cheapness and simplicity of the device compensates even for this defect, but in the case of water-lifts the possibility of using other and better methods of lifting water puts the gin out of court.

It is not unlikely that mechanical methods of lifting water will ultimately displace cattle power almost entirely, but that day is still far distant, and in the meantime it would be of great advantage to the agricultural community if authoritative and complete trials were made of the efficiency of the various indigenous methods of lifting water. Fifteen years ago with Mr. C. Benson, the then Deputy Director of Agriculture in Madras, I made some experiments in this direction which led me to the above conclusions, but it would be well if they could be repeated on a more extended scale and the relative merits of the different methods of applying power determined with greater accuracy than was possible with the limited opportunities we

then enjoyed for such experiments. Considering the enormous number of cattle power water-lifts at work in India, it seems to me that the interests involved will amply justify the trouble and expense of such investigation.

It is true that records exist of many tests of water-lifts, but unfortunately the results are of no comparative value as every observer failed to measure the strength of the cattle employed. A pair of bullocks is a vague term ; one pair may be easily twice as strong as another and some way of comparing the strength of the animals must be devised. Failing any better method, I assumed that for animals and men in good working condition their strength was for each class proportionate to their weight and though this may not be strictly accurate, there is no question that it does to some extent serve as an indication of the amount of muscular energy which can be obtained. Here it may be convenient to state that I obtained a very useful co-efficient or figure of merit by dividing the useful work done in foot pounds per hour by the weight of the animals in pounds. My experiments led me to the conclusion that we were not likely to be able to effect any marked improvement in the indigenous methods of lifting water. The development of the internal combustion engine a few years later rendered it possible, however, to employ mechanical power in place of men or animals wherever the supply of water exceeded a certain quantity and opened out a new field for experiment and investigation. The American windmill also seemed worthy of trial and during the last nine years in Madras we have been working to adapt these entirely novel sources of power to the service of the ryot. With the windmills, we have not met with much success owing to the general feebleness of the air currents, but it has been otherwise with the oil engine coupled to a centrifugal pump, as is attested by the fact that there are about 300 installations of this character at work in the South of India. The main objection to the oil engine and centrifugal pump is that it can only be worked economically when the quantity of water to be dealt with is large. Nine thousand gallons per hour may be taken as the economic minimum

that the centrifugal pump can deal with and there should be enough water to keep the plant at work for about 6 hours per day. Any extension of these figures means increased economy, and the larger the unit that can be employed, the more satisfactory is the result. With sufficient water, the cost of lifting it is from one-fourth to one-tenth the cost of the older methods, and volumes can be dealt with and vertical lifts tackled that are absolutely beyond the range of cattle power. We are still only at the beginning of this revolution in lifting water for irrigation, and no one can doubt that as it extends, the increased experience will render it more efficient and more adaptable to the every-day needs of the smaller irrigators.

These preliminary remarks on the subject of lifting water are necessary to explain the standpoint from which the following notes have been written on the display of water-lifting machinery at the Allahabad Exhibition. As a spectacle, the show round the lake in the Agricultural section was impressive, but a detailed examination of the exhibits leads to the conclusion that the problem of lifting water for irrigation has not yet received the attention in the North of India which its importance deserves. The exhibits may be divided into three main classes, according to the source of motive power: (1) men, (2) cattle, (3) engines, and only in the third section was there anything like a complete representation of the available methods. Indigenous methods of lifting water were conspicuous by their absence, and it is a matter of regret that no attempt was made to show one specimen at least of each of the methods of lifting water commonly used in various parts of India. For instance, in Madras we have quite a number of water-lifts which seem to be unknown in the North of India, and under suitable conditions the introduction might be attended with advantage. I might cite as examples the various forms of double *mhote*, the *picottah* and the Malabar scoop wheel. Where so much was done, it is perhaps ungracious to ask for more, especially as the erection and exhibition of these lifts in working order would have entailed much trouble and not a little expense on the authorities in charge of the Agricultural section.

Of water-lifts to be worked by men there were a great variety of pumps actuated by levers, all better suited for garden work and occasional use than for steady employment day in and day out on the irrigation of field crops. The only device really intended for irrigation was the chain pump exhibited by the United Provinces Agricultural Department. For low lifts up to, say, 5 feet it is probably an effective device as the pump is very efficient, gives a continuous flow of water, and the only objection to it is the mode of application of the power which is extremely simple but very fatiguing. For lifts above 5 feet its utility is doubtful and at 15 feet it is only about half as effective as a *picottah*. From a circular on pumps issued by the Agricultural Department at Cawnpore I find it is stated that four men working 10 hours a day will lift 6,806 c. feet of water to a height of 15 feet in two days. Assuming that the men weigh an average of 120 lbs. each, I calculate that they will do 319,000 foot lbs. of work per hour, and this number divided by their total weight gives as a figure of merit or co-efficient of utility, 664. This may be compared with a trial I once made with a *picottah*. The lift was $14\frac{1}{2}$ feet, and the three men employed weighed 331 lbs., and did 394,310 foot lbs. of useful work per hour—the co-efficient of utility being 1,191. The duration of the trial in this case was seven hours and the men worked in a normal way. This is by no means an unusually good result, and with an improved lift worked on the *picottah* principle, I have obtained co-efficients as high as 1,800. The chain pump is a very efficient water-lift, but the rotary method of driving it, though it has the advantage of being very simple, is not an effective method of applying human power. I doubt if it would be possible to satisfactorily arrange any system of treadles or levers to be moved by the weight of the operators, and such being the case, the advantageous application of the lift is limited to raising water a few feet.

In all the lifts worked by cattle the gin was used and the cattle walked in a circle about 20 feet in diameter. The gins were well and substantially made, but the rotating arm was too short except for small cattle, and a pair could only be effectively

employed by attaching one animal to each end of the rotating arm. This is unsatisfactory unless the animals can be trained to work without a driver to each of them. The gins were employed to drive chain pumps or *norias*. From data given in the circular of the Agricultural Department already referred to, it appears that the co-efficient of utility of a gin-driven chain-pump works out at about 470, which is about as good a result as can be obtained with the single *mhote* worked on the *Kili* system and somewhat better than when they are worked on the *lagor* system. My practical experience with chain pumps and *norias* is too limited to justify me in expressing any opinion on their merits as water-lifts for ryots' use. I once made some experiments on a *noria* and obtained a co-efficient of utility of 404, and from measurements made on the draught exerted by the cattle I found that as a machine it had an efficiency of 50 per cent. For low lifts the chain pump is undoubtedly superior to the *noria*, but on lifts of over 20 feet I have no information as to their relative efficiency.

Besides the bullock-driven chain-pumps and *norias*, there was exhibited a double trough water-lift called a "Baldeo Balti." I quote from the Agricultural Department circular the following description :—"It consists of two iron troughs, each having a valve at the bottom opening upwards. They are hinged on a beam fixed to the ground at discharging level and are alternately raised and lowered by ropes attached to the back ends of the troughs, passing over two pulleys and so to a horizontal beam pivoted at one end, which is pulled round by a single bullock walking in a circle." It is certainly a simple effective device for lifts of 3 or 4 feet, but its merits would be mainly determined by its efficiency and on that point I have no information. I am inclined to think it would be less efficient than a well-designed chain-pump.

It should be pointed out that chain pumps and *norias* are not suitable types of water-lift for wells in which the water level varies greatly. The load against which the power is exerted varies with the height to which the water has to be lifted, and

as the water goes down, the strain on the cattle increases. On a *noria* the load might be diminished by removing some of the buckets, but in practice this is not a convenient arrangement. Cattle working a gin walk at a uniform pace and exert a steady draught and to be employed in an effective manner the load must be steady and proportioned to the draught they can exert. Obviously this is impossible with chain pumps and *norias* if the water level varies. At the beginning of the day's work the load will be too light, or if properly adjusted to the strength of the animals, then at the end of the day it will be too heavy. It is possibly for this reason they have never found favour in the South of India where the Persian wheel is unknown and where the water level in the wells varies greatly.

The mechanical methods of lifting water may be conveniently regarded as consisting of a source of motive power and of a pump and that within certain obvious limits any source of motive power may be coupled to drive any type of pump. At Allahabad nearly every modern type of engine was at work in the exhibition and most of them connected up to pumps. It will be convenient to tabulate the exhibits in two columns.

Type of engine.	*Type of pump.*
Oil engines :—	Centrifugal pumps :—
1. Petrol.	1. Open impeller.
2. Kerosine oil.	2. Closed impellers.
3. Liquid fuel.	3. Self-regulating.
4. Diesel engines.	4. Multiple stage.
5. Semi-diesel.	Chain-pumps
Gas engines :—	*Norias.*
Vertical.	Cornish pumps.
Horizontal.	Three-throw pumps.
Steam engines :—	
Portable.	
Semi-portable.	
Windmills.	

It is only in the Madras Presidency that mechanical methods of lift-irrigation are at all largely used by the cultivators, and my remarks on the exhibits at Allahabad are necessarily based on the experience that has been gained in the Pumping Section of the late Department of Industries.

The steam engine may be dismissed with a very few words. Even where coal is very cheap it cannot be recommended as suitable for the ryots' work. By the use of superheaters the fuel consumption has been reduced to a very low figure, but the engine requires a skilled attendant who must satisfy the requirements of the local Boiler Acts. For very small powers it is hopelessly beaten by the internal combustion engine, but for larger powers where coal is cheap, as in parts of Bengal, it is still the best type of motor that can be employed.

For agricultural purposes the type of engine which should be recommended depends largely upon the relative cost of the different kinds of fuel which can be used in internal combustion engines. Over the whole of India the price of kerosine oil varies but slightly, whilst it is only in places that a cheap supply of liquid fuel can be obtained. In the Madras Presidency liquid fuel is about half the price of kerosine oil and the consumption per brake horse-power is by volume practically the same, so that, although liquid fuel is not so clean and nice to use as kerosine oil, the large saving in cost outweighs these disadvantages and renders it desirable to employ a type of engine in which it can be used without difficulty. At one time the Diesel and the Hornsby-Ackroyd engines were the only two which were quite satisfactory to use, but since the expiry of the Ackroyd patents there are a number of engines on the market by different makers all of which run well enough with liquid fuel. The Diesel engine is not suited for small powers and requires a skilled attendant to keep it in good running order. Its capital cost is also high, and for these reasons it may be considered out of the agricultural field. Within the last year or two English makers of oil engines have put on the market what may be termed a 'Semi-Diesel' engine, of which at least one example was to be seen at Allahabad. It was working very smoothly and the consumption of fuel, though higher than in the Diesel engine, was much below that usually obtained in ordinary oil engines working with liquid fuel. Where a portable oil engine is required, the work is not only intermittent but generally of a special

character that will bear the cost of a rather more expensive fuel, and there were exhibited several small vertical oil engines which would run on petrol or on kerosine oil if first started with petrol. Such engines invariably run at a very high speed and require to be of good design and the best possible workmanship. A cheap engine of this type is therefore not to be recommended, but if a sufficiently high price is paid, it is possible to get a really satisfactory motor. They are usually magneto fired and it is important that the magneto should be of an approved type. I have used one of these engines coupled direct to a 3-inch centrifugal pump during the last three years and found it admirably suited for testing water-supplies or any other work of a temporary character such as cleaning out temple tanks. I understand that the local conditions are such in the United Provinces that portable engines are likely to prove very useful, and I think that on the whole the light high speed type will be found better suited for this class of work than the ordinary type of oil engine mounted on a girder frame.

Where wood charcoal can be obtained at a cost not exceeding Rs. 20 per ton, gas engines and suction gas plants represent for anything over 10 h.p. the most convenient of type of motive power that can be employed. There are many designs of gas engine now on the market which work extremely well and with most gas producers charcoal can be used if adequate provision is made to remove the tar which invariably comes over. Suction gas engines are now made which will work with wood, paddy husks or straw, but they cannot well be employed for anything under 35 h.p. I have no extended experience of this class of fuel, but I am satisfied that they will do all that the makers claim for them, and I am now installing one to drive a 72 h.p. gas engine.

There were several windmills exhibited at Allahabad, but owing to the lightness of the winds during the exhibition it was impossible to get them to work against any load. Where fairly strong continuous winds can be relied upon, a windmill is a very suitable type of motor for well irrigation when the lift is not more

than twenty-five feet. On the West Coast of India and in the Deccan there is sufficient wind to make it worth while to put up these mills, but over the rest of India the air currents are usually too light and of too variable a character to obtain results commensurate with the capital outlay involved. It should be noted, however, that the wind velocities are usually the highest during the hot dry months of the year when water is most required.

Turning now to the various power-driven water-lifts attention may be drawn to the *norias* and chain-pumps. For small lifts, and not very large volumes of water, the chain-pump appears to have a possible future in front of it, but without prolonged experience as to the life of the chain and the general wear and tear and without accurate tests as to its efficiency I am not prepared to say that it is better than a centrifugal pump. Some well-designed *norias* driven by small engines were also exhibited, but I doubt if they can hold their own either in first cost, efficiency or durability with the best modern types of centrifugal pumps. For irrigation work it is hardly necessary to consider the various types of high pressure pump, either of the reciprocating type or the multiple stage centrifugal, as it will be a long time before agriculturists in India will be sufficiently advanced to venture to lift water from depths which will involve working against high pressures. It remains, therefore, only to consider the single stage centrifugal pumps, and of these practically every modern design was in evidence at the exhibition. It is quite beyond the range of these notes to enter into a discussion of the principles on which the various forms of this pump are designed. The efficiency of a centrifugal pump increases rapidly with increasing size, and pumps below 3″ in diameter of suction pipe should ordinarily not be employed. The majority of 3″ centrifugal pumps on the market have an efficiency ranging between 40 and 45 per cent., and the larger pumps will have an efficiency up to 55 per cent.; but during the last few years much attention has been paid to the design of centrifugal pumps, and 3″ pumps can now be obtained with an efficiency of 70

per cent. and the larger sizes with an efficiency of nearly 80 per cent. These pumps are naturally more costly than the older types, but they require for equal quantities of water delivered a much smaller engine, and we find in Madras that it pays well to buy centrifugal pumps of the highest efficiency obtainable as the combined cost of the engine and pump is lower and the working expenses permanently less. Where the vertical lift on which the pump works varies considerably at different times of the year, or as often happens in wells during the course of the same day, there is a great advantage in using self-regulating pumps, and these can now be obtained which practically take the same amount of power over a very long range of lift. This is a very important matter when internal combustion engines are used, as such engines can only be efficiently worked near their maximum load and will not stand any over-load whatever. Till the self-regulating pumps came on the market we often fitted the ordinary type of centrifugal pumps with two fast pulleys of different diameters so that the speed of the pump could be roughly varied to suit marked changes in the height of the lift. Previous to the adoption of this practice the variations in the water-level rendered the working of centrifugal pumps extremely unsatisfactory, and in more than one instance I have known a rise in a river so increase the load thrown by the pump on to the engine as to pull it up. This may sound paradoxical, but it is well known to those who have much experience in the working of centrifugal pumps and the difficulty has been entirely eliminated since attention was first drawn to this point in one of our reports on Irrigation by Pumping.

The exhibition of water-lifts at Allahabad demonstrates conclusively that Mechanical Engineers both in England and India are becoming alive to the fact that a great market awaits them in connection with lift-irrigation in India, and we may confidently expect that competition for business will lead to a careful study of the problems and that great improvements will ultimately result. It is a matter for regret that the recently invented Humphrey Gas Pump did not arrive in time to be shown in

working order at the exhibition. It represents a revolution in our methods of generating power, but the exact range of its application can only be determined by practical experience. So far, the pumps constructed have been of a capacity much greater than will ordinarily be required in India, and it is certain that the details of the design will require to be greatly modified before it has any chance of proving a serious rival to the small pumping plants for which a very big field undoubtedly exists in India.

III.—AGRICULTURAL PRODUCE.

By E. J. WOODHOUSE, B.A.,

Economic Botanist to the Government of Bengal.

The exhibits in the agricultural and irrigation machinery section of this exhibition can probably be considered to hold forth good prospects of considerable improvement being effected at an early date in the methods of cultivation and irrigation used by the more enlightened Indian agriculturists. On the other hand, the exhibits in the Agricultural Produce section serve rather to show what an immense amount of work there is yet to be done on Indian crops, before they find their correct uses and attain their correct position in the markets of the world.

Before discussing the Produce section as a whole, it will be well to review briefly the exhibits shown in this section. The majority of the exhibits were housed in two buildings to the south of the Irrigation tank. These buildings were about 100 feet long and were conveniently arranged in the form of a cross with benches round the sides made up of two shelves, the upper one foot and the lower one foot six inches broad. Additional space was added by dividing up the longer sides into eight bays, about 10 feet by 10 feet, in addition to the larger one in the centre of each side. Down the centre of the building were arranged stands for exhibits, models, and large show cases. The

eastern building was largely occupied by a large number of wheat samples, classified according to the system in Howard and Howard's "Wheat in India." Next to the wheat samples were set models of wheat elevators and flour mills. A part of one side of the building was occupied by diagrams and baskets of grain showing the results obtained by the use of different manures on wheat, maize, and potatoes, and the effect of sowing maize broadcast and in lines. In the west bay Messrs. B. C. Gupta, & Co., seed merchants of Sisauli, had a good exhibit of their seed grain. Some interesting exhibits, organised by the Registrar of Co-operative Credit Societies and the Muzaffarnagar Zemindari Association, were also shown in this building. A stand in the middle of the building was occupied by an exhibit from Pusa, demonstrating the value to the agriculturist of the commoner Indian birds. On the upper shelf of the stand were set up stuffed specimens of the commoner birds ; and below them were arranged show cases containing the various insects constituting their food, divided up into classes according to the harm or good they do to the agriculturist. In addition to these there were a large collection of entomological show cases, and on the wall above them a number of plates of insect pests, arranged in frames according to the crop damaged. A good show case of scientific apparatus, together with specimens illustrating the life-history of insects and protective resemblance in insects, was exhibited by Messrs. Lawrence & Mayo in this section.

The second building was devoted largely to rices, oilseeds and fibres, in addition to which there was a collection of machinery exhibited by Messrs. Volkart Brothers, Karachi, and a model of the Skeen water-lift, recommended by the Bombay Department of Agriculture for utilizing the weight of one man and a bullock. Messrs. Thacker, Spink & Co. had a good assortment of agricultural literature, and the Peninsular Tobacco Company, Monghyr, had a large stand of tobacco exhibits. Down the centre of the north end of the building were arranged a series of exhibits of brushes, cotton seed oil, and sugar manufactures by Messrs. Begg, Sutherland & Co., and in the centre of

the building was placed an excellent ornamental stand of linseed oil exhibits, with working models, by the Gourepore Co., Calcutta. In this building there were also exhibits of sugar by the Cossipore Sugar works, and of tea by the Eagle Tea Co.

South of this building was the Pusa silk house containing a large number of useful machines, such as a loom, combined twisting and doubling machine, Pusa continuous spinning machine, and Coryton reversing machine, for *eri*, and the Bengal reeling machine for mulberry silk; the working of all of which was being demonstrated by trained coolies. In addition there were specimens of all the various kinds of cocoons and crosses made with them, and a large number of pieces of cloth made and dyed in Bihar. Some of the colours obtained were very pleasing; and it is hoped that there will be a good demand for the silk ribbons and cloth for use as carriage rugs, purdahs and dress materials. Leaflets on the subject of *eri* and mulberry silk cultivation were also obtainable in this section.

One of the best exhibits in the agricultural section was the pot culture house devoted to cottons, which illustrated the work that has been done in the United Provinces in the improvement of the local cottons. The exhibit consisted of a central stand, on which were arranged photographs of the varieties on which work is being done, and drawings illustrating the behaviour of the characters of flower and leaf colour in crossing; from which it is possible to identify the accidental crosses which arise in cultivation. A series of cottons on ruled paper also showed the length of fibre attained by crossing the common short-stapled form with a longer stapled variety; in the first generation a regular intermediate form was obtained, and in the second generation the long and short-stapled forms were found to separate out. As a result of this work it is hoped that it will be possible to introduce a good, hardy, short season variety with lint of good length. Round the outside of the exhibit were growing specimens of the different varieties of cotton.

In the Fruit House there was a fruit bottling outfit and a good collection of bottled fruits from the Kumaon gardens,

including cherries, apples, peaches, plums, apricots and various wild fruits. Among the fresh fruits were a number of dishes of apples, pears and walnuts from Almorah, some thin-skinned walnuts from Garhwal, a good collection of persimmons from Bhowli and a collection of citrus fruits from Kumaon. In the vegetable section there was an excellent collection of potatoes from Naini Tal, and an assortment of vegetables from the Kumaon gardens.

Of the various exhibits of agricultural produce, the rices were well represented and were made more easy to judge by the fact that samples of both rice and paddy had been requisitioned for exhibition, in addition to specimens of the ripe plant, which were mounted on frames, and considerably improved the appearance of the exhibits. Except in a few cases, the rice had been badly cleaned by the sun-drying process, and there were very few good samples of clean white unbroken rice. The best table rices exhibited were *Bansmati*, *Hansraj*, and *Ranjewain*, which latter variety appears to be the same as the *Dadkhani* variety of Bengal. It is said that there are only one or two fields in a few localities where *Bansmati* can be grown successfully, and in those localities the paddy is so sweetly scented that it can be recognised at a considerable distance, when ripe for harvest. The broadcast early rices were particularly badly cleaned, the most prominent being a red-grained variety, *Shati*, which appeared to be the same as that cultivated in Bengal. Of the wheats there were also a large number of samples of all the common types, but they did not appear to be so pure as the samples of rice exhibited. In the barley section there were a number of specimens of huskless barley, which looked well, but the variety is said not to yield so well as the ordinary. Of the oilseeds, there were a good number of specimens with good samples of oil attached to many of them. In the fibre section there were a number of excellent samples of jute, Manila hemp, Sannhemp, Urena, Sida, etc., sent by the Fibre Expert, Eastern Bengal and Assam, and some specimens of *Madar* (Calotropis) floss woven into cloth, exhibited by the

Agricultural Station, Aligarh. There were also a number of forest fibres exhibited by Dr. V. S. Joshi of Ratnagiri, Bombay. It is difficult to criticise the exhibits in the Fodder House, as most of them were pulses and cereals usually used as human food-stuffs. The difficulty of judging the exhibits was increased by the fact that a large proportion of the exhibitors had not complied with the requirements of the schedule. The arrangement of samples, which were not for competition, in the classes to be judged, also increased the difficulties of judging.

We may now leave the consideration of the individual exhibits to consider the Produce section as a whole. The statement in the official handbook that the general idea underlying this section had been "the intimate association of processes and products" shows that it was intended to function as a temporary Museum of Economic Products as well as an Agricultural Show with classes for competing entries. In order to understand how agricultural exhibitions have developed on these lines it is necessary to go back some years. It would appear that the exhibits at the early Indian Exhibitions consisted of samples brought together with the intention of submitting them eventually to European experts for report on their merits. At the Nagpur Exhibition of 1908 a small collection of the chief crops of the province with the recommendations of the local Department of Agriculture was staged separately from the section open to samples for competition. The chief object of the Lahore and Allahabad Exhibitions appears to have been the collection of as many samples of each crop as possible and their arrangement together, irrespective of their source, in order to make as imposing a display as possible. In other words, in these two exhibitions the functions of a museum and a competitive show were not differentiated.

A little consideration will show that these two objects are quite distinct. The use of an exhibition as a means of making an agricultural and industrial survey of a province for educational and museum purposes necessitates the collection of small samples of all the products found in the various tracts and the

preparation of models of the processes by which they are prepared for the market. With the present organisation throughout the Provinces of India such a survey, if necessary, can be made more efficiently in other ways. For an Agricultural Exhibition to perform the function of a Museum, only one sample of each product or process will be required and that must be the best of its kind. The exhibits should also be very carefully labelled, so that the public can see at once the advantages of each. On the other hand, in the case of a show proper there will be a class for each of the principal varieties of the crops and implements, etc., grown or useful in the locality ; in each class many specimens of varying degrees of merit will be staged, and those considered by the judges as the best of each kind will be awarded prizes.

In order to show clearly what must happen if no distinction is made beween the exhibits shown for educational purposes and those shown for competition, it will be convenient to take a hypothetical case. At Allahabad there were a large number of samples of crops from various Associations and Government farms exhibited among the competitive entries, but not intended for competition. Now, supposing that a sample of the best of the improved wheats from a Government farm was exhibited in one of the wheat classes, where the rest of the entries were of poor quality ; in judging the class it would be necessary to pass over the improved wheat, which was not for competition, and give the prize to a much inferior sample. The result would be that any member of the public who studied the exhibits in this class intelligently would at once infer that the improved wheat was really of inferior quality, and that wheats of the type of the winning sample were those which would be likely to fetch the highest prices. Cases exactly similar to this did actually occur at Allahabad. It is quite conceivable that this practice of combining an educational museum with a competitive show may give results the exact reverse of those desired.

An Agricultural Exhibition, to be successful, must therefore not be inspired by a mixture of ideas however good in themselves.

Both the demonstrations and competitions have as one object, the setting up of correct standards of excellence for the crops of the country, but, if it is desired to combine the two methods, this should be done by including in a separate museum exhibit, samples, approximating as closely as possible to the ideal, of types of all the principal crops grown in the country, with labels giving the current valuation and other remarks on the advantages and disadvantages of the crop. The competing exhibits would then be classified according to each of these types, and the prizes awarded according to the approximation of the exhibits to the standard set in the Museum. Implements, models, etc., could be treated on a similar system.

It may be asked whether it is possible to lay down definite standards of excellence for the majority of Indian crops; and to anyone who has been faced with the problem of judging a long line of samples of *Cheena* (Panicum miliaceum), this question will seem a very pertinent one. Undoubtedly there are a large number of crops, concerning which very little is at present known, but it will be found that in the case of many of these crops, such as paddy, *rahar*, *mung*, there are definite local standards of excellence.* In the case of such crops it is only possible to award prizes according to the requirements of the local bazars, at the same time taking into account the purity, cleanliness, and thriftiness of the sample. On the other hand, the staples of European consumption, among which may be included wheat, cotton and other fibre crops, have very definite standards; and it is by instituting classes for these crops in particular that agricultural shows can disseminate a knowledge of the factors which go to make up the value of a sample. To be effective, this work must be begun by means of small shows held in the heart of the various agricultural tracts.

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* Some information on this head has been collected in the Bengal Department of Agriculture's Record 1 of 1910, *Suggestions as to the organisation of agricultural exhibitions*. There is an immense amount of work yet to be done in isolating the "Varieties" (unit species) of the minor crops, finding out the reasons for the local preferences, and inquiring into the possibilities of an export trade in them.

The future development of agricultural shows will probably lie in the improvement of the classes for competition. A reduction in the number of the produce classes can be made by eliminating classes for minor crops, which have probably only been retained on the schedules of exhibitions on account of the small amount of information that exists concerning them. Such a reduction in the number of classes will enable the prize money to be increased in the important classes. At the same time the size of the samples can probably be increased until they may eventually reach a maund, which will enable judgments to be given on a more commercial scale. The development of the competitive side of an exhibition on these lines will make the present scheme of arrangements and decorations more or less impossible, except round the stands where the selected exhibits for demonstration purposes are separately staged. The efficiency of the demonstration section will be increased by its isolation from the competing exhibits and by the improvement of the methods of staging and labelling.*

The moral of the Allahabad Exhibition seems to be that an exhibition of mechanical appliances for agriculture tends to attract the attention of innumerable commercial establishments fully alive to the advantages which may accrue to themselves from the application of the mechanical ingenuity at their command to the problems of Indian Agriculture, and may therefore be of the utmost utility, but that no real development of exhibitions of agricultural produce on the scale of the Allahabad Exhibition can take place until very much more is known of the economic possibilities of Indian crops and the characters of their constituent varieties. In the meantime small shows, held in the

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* In Bengal the larger departmental exhibits are arranged in a separate tent, and the crop exhibits are divided into two sections, the varieties of the crops recommended by the Department for general cultivation and the general crops section containing samples of the chief varieties usually grown in the Province and intended to show the public the crops which can be grown in the Province. It is as a result of the interest taken in a flood-resisting paddy, exhibited in this section, by the cultivators at Singheswar *mela* that a deep water paddy is being successfully introduced into North Bhagalpur. Further information regarding the setting up of these exhibits can be obtained from Record 2 of 1910.

heart of agricultural tracts, can be effectively utilized to advertise the recommendations of the Agricultural Department, to set up correct standards for the important staples, to show the value of good clean samples of other produce, and to encourage the spirit of competition. Incidentally they will also be found to provide material for the Department's survey work at a minimum of expense.

SUGAR-CANE IN INDIA.

By J. WALTER LEATHER, Ph.D., F.I.C.,

Imperial Agricultural Chemist.

India is importing more than half a million tons of sugar annually.

THIS statement will sufficiently indicate the object of the present article. It is not merely that the above indicated quantity is large, but it is also one that is constantly increasing. Twenty years ago India purchased 100,000 tons of sugar; ten years ago the import had risen to 300,000 tons; now it is in excess of 600,000 tons. The fact is all the more striking when it is recollected that India produces more sugar than any other country, the estimated production being about three million tons. Two questions at once occur to the mind, which are :—

(*i*) is the transaction a sound one? and

(*ii*) can it be avoided?

The reply to the first of these is, I think, both simple and definite. During the last twenty years the cultivated area has increased by about 21 million acres, which area has been utilised for the expansion of the wheat, cotton, oil seeds and food-grain crops; at the same time there has been no corresponding increase in the sugar-cane area, which has in fact suffered some slight decline. These facts are demonstrated by the following statement :—*

Statement of areas in British India (Millions of Acres).

	Total Cultivated area.	Wheat.	Cotton.	Oil seeds.	Sugar-cane.
Average of 5 years 1894-95 to 1898-99.	191	19·6	9·4	12·6	2·8
Average of 5 years 1899-1900 to 1903-04.	198	19·8	10·2	12·6	2·5
Average of 5 years 1904-05 to 1908-09.	212	22·0	13·4	13·4	2·4

* Agricultural Statistics of British India.

As a business transaction, the position is perfectly sound; for it is clear that under present conditions it pays the Indian cultivator better to grow other things than sugar and to purchase the latter. It is an example on a very large scale of what happens in the case of many districts on a much smaller one, some of which never grow any sugar at all, but always purchase what they require.

But when we turn to the second question and consider whether India can avoid purchasing these large quantities of sugar, the answer is by no means simple. In one sense the position can be defined, for it is evident that it will only pay the cultivator to grow more sugar if (i) its price rises, or (ii) the crop can be raised more cheaply, or (iii) more sugar can be produced per acre, or naturally if a combination of these conditions can be realised. Regarding (i) it is highly improbable that any rise in price will occur. It is true that the world's demand for sugar constantly increases, but the future of sugar may be expected to be similar to its past, and it will be produced more and more cheaply. There is, however, one important point which deserves mention here. Whilst it may be expected that sugar will become cheaper, there will be a limit to such fall in price, because there is no probability that all the other sugar-producing countries could together supply India's whole demand. The latter is about 3·5 million tons. At the same time, even supposing one million tons were imported, this would be no reason for assuming a rise in the price. Also in respect of condition (ii) which implies cheaper labour, there is no probability of this being realised; wages will rise and agricultural machinery has not so far helped to decrease the labour bill for cultivating or harvesting the sugar-cane crop. At the same time there is some evidence that the cost of cultivating an acre of cane in India is high. Hadi estimates* this at about Rs. 65—80 per acre. It is not easy to compare accurately the cost of cultivation in other countries, but so far as I am able to do so, the following may be given. Cuba, Rs. 100;

* Sugar-cane Industry of United Provinces, p. 42.

Louisiana, Rs. 26; Java, Rs. 30.* The Cuba estimate is based on a production of about 30 tons cane per acre. But if the cost in India is really greater than in Java, it is difficult to see how it can be reduced. The solution of the difficulty clearly depends on condition (iii), and if India is to avoid her current very large sugar bill, she must increase the outturn per acre and extract a larger proportion of the sugar which is in the cane.

It will probably be best to consider first the question of extracting a larger proportion of the sugar from the cane. It is well known that the amount of juice expressed from cane depends on the efficiency of the mill. We are not considering here whether one sort of cane will yield more juice than another, but purely the outturn of juice from any cane when crushed by good and bad mills respectively. The best mills are no doubt those which are working in the large factories. Here the presence of the engineer secures that the mills are kept in good repair, and over and above this, the cane passes from the first mill along a "feeder" to a second mill and is on the way wetted with water, so that a further quantity of juice is obtained, albeit much diluted; and this process is repeated a third time in the most modern factories. Passing from this in the downward scale, we have power-driven mills badly cared for, the small iron bullock-driven mills so largely used by the cultivator, and finally the old wooden mills of various patterns which have practically disappeared in India. Comparing the small bullock power iron mill which has come into such general use in India during the last twenty years, with the best steam-driven mills, it is quite easy to argue that the latter will extract much more sugar from cane than the former. If both are in good repair, it is probable that the steam-driven mill will extract from one-eighth to one-fifth more. With the aid of the *best* mills, with double and treble crushing 90 to 94 per cent. of the juice is obtained,† from which we may deduce the following. It is usual to obtain from the thick varieties of

* Das Zuckerrohr und seine Kultur by W. Krüger, p. 481.

† On cane-sugar and the process of its manufacture in Java, by H. P. Prinsen Geerligs, p. 23.

cane grown in Southern India 70 per cent. juice, the total being about 90 per cent. in the cane. A steam-driven mill of *good* type with double or treble crushing will not extract more than about 80 per cent. From the thin canes containing about 85 per cent. juice, a good pattern bullock-power mill will extract 60 per cent., whilst a steam-power mill would extract about 76 per cent. Unfortunately the small bullock-driven mill is often at a disadvantage for want of being kept in good order. For example, in a test made by Mr. Mollison some years ago at Dharwar* one iron mill expressed one-sixteenth more juice than another pattern, and Khan Bahadur Md. Hadi quotes† cases in which a well-made mill extracted from one-tenth up to one-fifth more juice than mills found in villages. Again, Mr. Moreland has stated‡ that the examination of the stock of mills in one sugar centre revealed the fact that not one was fit for use, and the same was found in another large tract of country, and he adds "at a very low estimate I believe that the effective yield of juice per acre could be increased by 10 to 15 per cent. if efficient mills were procurable." In fact, one of the chief defects of the small mill is the difficulty of maintaining such a very large number in good working order.

Adding to defective working the fact that the best of these small iron mills could not compete with the best power mills in which the cane is "double" crushed, one is apt to assume that, were all India's cane crushed by the latter, an increased yield of something like one-fifth more sugar would result. And one-fifth more sugar is equivalent to India's imports! But such an estimate overlooks one or two features which considerably modify it. In the first place, all the cane of India will not, in our time, be crushed by the best power mills. Circumstances are generally opposed to such a huge change. Then, secondly, power mills are not necessarily better than the small iron mill. For instance, at the recent

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* Agricultural Ledger, 1898, No. 8, p. 21.

† Sugar-cane Industry of United Provinces, by S. M. Hadi, p. 61.

‡ Agricultural Journal of India, II, p. 16.

Exhibition at Allahabad one of the latter type beat several power mills in open competition, though it must be here noted that the latter were only "single" crushers ; that is, the begass was not treated with water and then again crushed, as in the more perfect types. Thirdly, very large quantities of cane are required to feed a good steam-driven mill, and this means almost necessarily a serious delay after cutting the cane before it is crushed. For instance, cane has to be brought some 40 or 50 miles by rail at the present time to some of the mills in India and is certainly not crushed before the second or third day after being cut in the field. Mr. Nöel-Paton in his valuable paper "Notes on Sugar in India" places great weight on the importance of this factor. Cut cane suffers depreciation if not crushed within 24 hours. But he errs when he attributes (p. 38) to the general Indian practice, loss from this cause. One of the great advantages of the present system in India is that the cane is cut only as it is required, and hence does *not* suffer from this source of depreciation. Indeed loss of sugar from this cause would have to be set against the various advantages which the steam-driven factory offers. In any case, whatever extension of steam power crushing there may be in the near future, it is certain that this will not make any *large* difference in the amount of sugar which is obtained from the cane grown.

So long as the greater part of the people of India are satisfied with *gur*, its production is neither a loss nor a disadvantage, but rather the reverse, because both in the sense of a sweetmeat as also in that of a food-stuff the molasses included in the *gur* is just as valuable as the cane sugar. An increase in the number of factories in India is no doubt desirable in order to supply a part at least of the demand for white sugar, but they will not be a means of increasing the sugar *production* in any marked degree. If the *production* is to increase, it must be by means of (*i*) a larger outturn of cane per acre, (*ii*) the cultivation of cane yielding more sugar at the mill, and (*iii*) an extension of the area under cane, and the problem is largely independent of whether the cane is crushed by the cultivator or goes to a factory. In

approaching this subject it is well to compare the outturn of sugar per acre which is realised in different countries; Java seems to head the list with an average of 3 to 4 tons per acre; Demerara, Mauritius and Queensland produce rather under 2 tons. Coming to India we have :—

Bombay*	...	... 2·5 tons per acre.
Madras ...	...	... 1·9 ,, ,,
Eastern Bengal & Assam		... 1·05 ,, ,,
Bengal ...	...	... ·9 ,, ,,
United Provinces	...	... ·8 ,, ,,
Punjab ...	...	... ·6 ,, ,,

Although these figures for the several countries are not strictly comparable, because "sugar" in countries outside India means more or less refined sugar, whilst in India it means *gur*, they are nevertheless useful for our purpose.

Firstly, they show how much more is obtained per acre in most countries than in India. It seems certain that, so long as the disparity is so great as it is, so long will these other countries be able to produce sugar cheaper than India can. That this is not principally due to the central factory system is certain. The figures represent principally differences *in the field.*

Then, secondly, considering the Indian outturns, it is evident that the tropical parts of India produce considerably more sugar than the United Provinces and the Punjab. And in this lies probably one of the "keys" of the situation. It so happens that by far the greater part of India's sugar-cane area lies outside the tropics, and concurrently a considerably lower yield per acre is realised. The question then arises, is it reasonable to expect that these sub-tropical countries can ever produce such yields as the tropical countries do? And here let it be noted that India's cane is not of low quality in so far as proportion of sugar in the juice is concerned. Average cane-juice in Java contains from

* Last five years' average from "Final Government Memorandum on the sugar-cane crop of the season 1910-11" issued by the Commercial Intelligence Department.

15 to 17* per cent. of sugar, which is certainly not higher than that of Indian cane. These figures will appear low to some readers. It is quite true that *some* cane grown in Java is richer than this and runs up to as much as 20 per cent.; but this is likewise the case in India. The defects of the Indian crop are (*i*) small weight of cane per acre, and (*ii*) a high proportion of fibre in the cane, which causes, especially in single crushing, a low yield of juice.

The production of more cane per acre and of cane yielding high proportions of juice, containing high proportions of sugar, are subjects well understood, but the solution of the problem in India is not by any means a simple one. The United Provinces include more than half the sugar-cane area, and the visitor from other cane-growing countries is at once struck by the small thin canes which are nearly universally grown. Why grow such cane, a cane indeed which contains a high proportion of fibre and consequently yields less juice to the mill? As a matter of fact, the general growth of these thin canes is not due to mere ignorance on the part of the cultivators. Thick canes of better quality are grown in small quantity very widely throughout the Province and are called *Poundas*, which are, however, generally sold for chewing, and only in the Meerut Division is a moderately thick cane crushed for sugar manufacture. Why is this the practice? One reason given is that the *Poundas* are not "sweet," that is, the juice is said to contain a low proportion of cane sugar. Such evidence as we have does not support this argument. Even if the *Ukhs* are somewhat sweeter, they contain less juice. Assuming for example that the juice of the *Ukhs* contains on the whole 17 per cent. sugar whilst *Poundas* contain 15 per cent., then since the *Ukhs* yield about 55 per cent. juice, and the *Poundas* 70 per cent. juice at the mill, 100 pounds of *Ukh* cane will yield $17 \times \cdot 55 = 9\cdot 35$ pounds of sugar at the mill, whilst 100 pounds of *Pounda* will yield $15 \times \cdot 7 = 10\cdot 5$ pounds of sugar. Other reasons are that the *Poundas* are more liable to disease

* Das Zuckerrohr und seine Kultur, by W. Krüger, p. 156.

and are more freely attacked by jackal and pig. Also they have not generally tillered so well in Behar as they do in Southern India.

A first consideration towards the improvement of cane as a sugar producer is the cultivation of a cane which will grow well in the particular locality. Nothing has been more striking when attempting to improve the yield of cane than the sensitiveness of newly introduced canes to novel environment. This is of course well known, but perhaps not generally realised. For example, two varieties of cane were obtained from Mauritius in 1894 for growth at Poona.* In respect of weight of cane they did well, but instead of yielding juice containing 18 per cent. sugar as had been expected, they only contained some 10 to 12 per cent. They only slowly improved. Similarly canes brought from Poona, from Burdwan and from Saharanpur to Cawnpore in 1897 grew very defectively. At Pusa, too, many of the varieties which have been obtained from other parts of India have failed to do well. At the same time, and conversely, some have done well, and have yielded good crops of sound and rich cane, though subject to disease in certain years. Curiously, too, among those that grew well at Pusa were the two Mauritius canes from Poona which did so badly there at first. These yielded juice containing 18 to 20 per cent. of sugar.

Thus it follows that when attempting to improve the cane of a district, a most laborious piece of work is involved, extending as it must do over a number of years, in order to ascertain what varieties from other parts may do better than the local one. Again, what is ascertained to be the best cane at one Experiment Station is not necessarily applicable to a whole Province. Owing to differences of soil and climate each sugar-growing Province in India would require several sugar-cane stations in order to make the work at all complete. And the work cannot be much abbreviated, excepting that in some parts, more particularly the tropical parts of India, the varieties already grown are of a high quality.

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* See this Journal, Vol. I., p. 413.

This is the line of investigation adopted by Mr. Clarke, Agricultural Chemist, United Provinces, and is one of the most important that can be followed.

Another means of increasing the outturn of sugar per acre is by liberal manuring. It is unnecessary to say that the crop responds to liberal manuring. It is not, however, the case that the cane land is not manured in India. Probably no crop is treated more liberally than is the sugar-cane crop in respect of good cultivation and manure. In some parts, notably the Deccan Districts, very liberal quantities of manure are used, and it is here that the outturn is very high. In most parts, especially the United Provinces and the Punjab, the quantity of manure employed is certainly small. In fact, in this respect the crop suffers like all others in India. At the same time it would be a mistake to suppose that by liberal manuring the outturn can be increased one hundred per cent. Some experiments were made at the Cawnpore farm between the years 1897 and 1903 with the object of trying to obtain there as large outturns as are commonly obtained in the Deccan. These showed that the heaviest crops raised were not one-half as large as those obtained in the Deccan, and moreover some of the cane, more especially the thin "*Ukhs*," suffered depreciation in quality. Moderate allowances of manure would no doubt be of advantage, but to employ the large quantities which are used in Southern India would probably do harm.

Passing from these considerations regarding the increased yield of cane in areas already under the crop, to the question of a possible extension of area, we meet with two facts. The one is that, despite the constant increase of total cultivated area, large increase of imports, and increased price of *gur*, there has been a contraction of area under sugar-cane. The three five-year averages which I have quoted indicate a contraction of some 400,000 acres in 15 years. Statistics are perhaps not altogether reliable in such cases. For instance, the contraction in the United Provinces in 1910-11 in comparison with the previous five years is some 200,000 acres, but so recently as

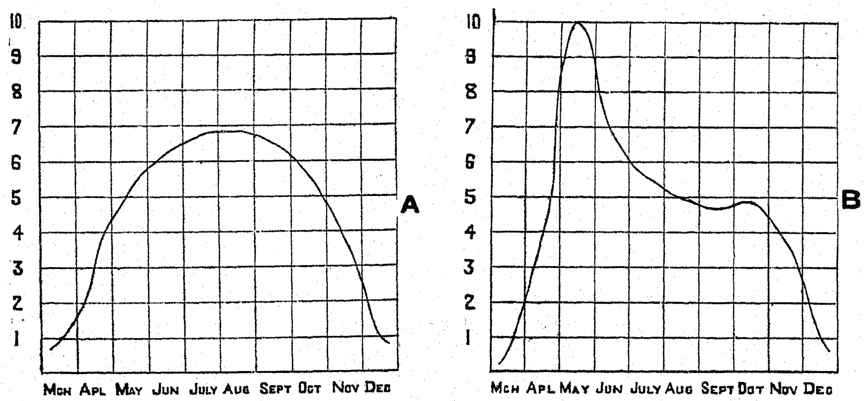
1907-08 this Province grew the largest area of the last 20 years. On the other hand, the Punjab crop of 1910-11 was one-third greater (more than 100,000 acres) than the last 5 years' average, but the latter included two crops very much below the average. At the same time there is, I know, a general feeling of anxiety in regard to the United Provinces crop, for if it is not contracting, it is certainly not expanding. In Bengal, too, which includes the second largest area, the answer is even more definite. It seems then unreasonable to hope for any large expansion in this part of India. Other crops pay the cultivator better.

One of the most curious facts in relation to India's sugar-cane area is that it is nearly entirely situated outside the tropics. How comes it that the country which produces more sugar than any other should grow the crop in the more temperate parts, whilst nearly all the rest of the world's cane is grown in the tropics? It is certainly not because the outturn is large. As already demonstrated, this is far below the tropical average. The explanation is probably two-fold. Firstly, the Indo-Gangetic alluvium is a soil which possesses an unusual fertility; a fertility probably largely due to its water-holding capacity. A crop can exist in it through the hot weather when it would fail in most soils. Secondly, and probably principally, the facilities for cheap irrigation have been greater in the United Provinces than in other parts. The canal-irrigated area has always been large and where dependence has been on wells, the sub-soil water is near the surface. There is also some support to this explanation in the fact that the Punjab is the only province in which a distinct increase of area under cane has occurred in recent times, and this is the province which has had a large increase of canal irrigation. But is it not a fundamental mistake for India to grow most of her cane in those parts where the outturn per acre is necessarily so much below that of competing countries? The fact of it being so at present is not a complete answer. One might have hoped that with the increased irrigated area in Madras, some sign of an increased area under cane would

become evident, but apparently her people find it pays better to grow *cholum* (Andropogon sorghum). Eastern Bengal is again another Province possessed of a climate more in accordance with the requirements of the cane crop, but here jute holds the "field."*

But if, for one reason or another, it pays the Indian cultivator better to grow other crops than cane, why should not Burma make an attempt to compete with Java and Mauritius? The climatic conditions are there more nearly akin to what is required. The dry "hot-weather" as it is understood in the Gangetic Valley is absent. In its place is a heavy rainfall distributed throughout the months of April to November; the temperature is considerably more uniform and does not reach the high figures so common to the United Provinces; at the same time the humidity is considerably higher.

These climatological features are much more in accord with the requirements of the sugar-cane. The hot weather of the United Provinces occasions an excessive transpiration of water. In some recent work on this subject at Pusa, we found that the curve representing the water requirement of sugar-cane was as illustrated in the chart B, whereas in a humid climate it would



* Since writing this article I hear from Mr. Meggitt, Agricultural Chemist, Eastern Bengal and Assam, that he can grow very heavy crops of cane at Jorhat, and that there are large areas in Assam which are available and suitable, both as regards soil and climate, for the crop.—J. W. L.

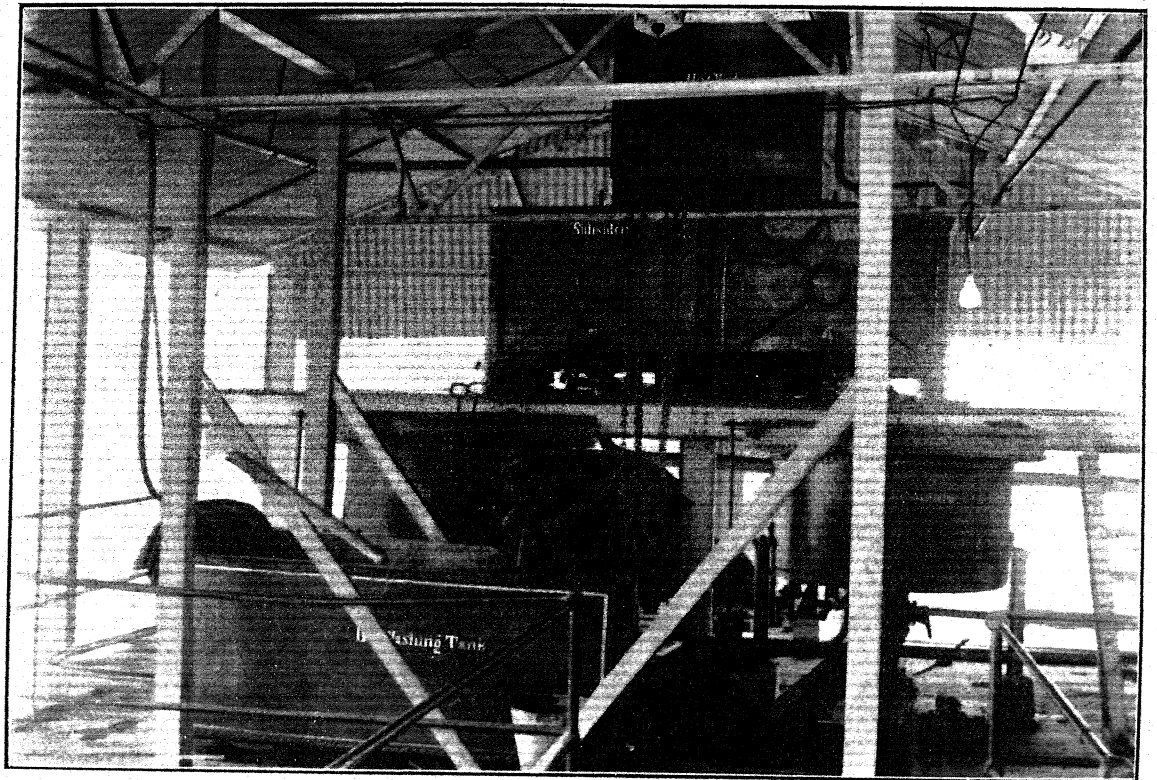
have been more like that in chart A. We may put the matter in figures thus :—

	March (2nd half).	April.	May.	June.	July.	August.	September.	October.	November.	December (1st half)
Temperature 8 A.M. ° F.	76	79	84	85	82	83	83	77	66	56
Relative Humidity 8 A.M.	47	50	64	79	87	86	89	83	84	85
Calculated water transpired by crop of 20 tons cane per acre ...	·3″	4·0″	10·0″	6·7″	5·7″	5·0″	4·6″	4·9″	3·5″	·8″
TOTAL ...	...	...	...	...	...	...	...	...	...	45·5″

Thus, owing largely to the low humidity and high temperature during April, May and June, especially in May, the water requirement was considerably greater than would have been the case under more moderate conditions. The water indicated in the statement is that actually transpired by the plant, in addition to which there will be a further considerable quantity which is simply evaporated from the soil.

But in any case it must, I think, be accepted that so long as India's principal sugar-cane area lies outside the tropics, so long will the yield per acre remain far below that of the other principal producing countries.

PLATE XXXIII.



A. J. I.

THE SUBSIDERS AND ELIMINATORS.

The bag filter (open for cleaning) is seen in the right hand corner of the foreground.

THE SUGAR FACTORY EXHIBITED IN THE AGRICULTURAL COURT, ALLAHABAD EXHIBITION, BY MESSRS. BLAIR, CAMPBELL & McLEAN.

BY B. C. BURT, B.SC.,

Deputy Director of Agriculture, United Provinces.

As this factory formed one of the most popular exhibits in the Agricultural Court, a few notes describing the result of the season's working will probably be of interest to readers of the *Agricultural Journal*. The inefficiency of the ordinary native method of preparing sugar, even when carried out by skilled sugar-boilers, as is the case in the Rohilkhand division of the United Provinces, is well recognised. The difficulties attending the introduction of large central factories are also equally obvious. The present plant, although by no means the first modern sugar-making plant erected in these provinces, represents the most recent and probably the most successful attempt to combine the efficiency of modern sugar-making machinery with a capacity suited to the conditions under which cane is commonly grown in the U. P.

This factory is designed to turn out 1½ tons of white sugar per 24 hours working with average good cane. In design it differs little from larger factories except in the omission of an intermediate vacuum evaporator. The cane was crushed in a 5-roller mill fitted with a pair of splitting rollers and with three crushing rollers. With ordinary good thin cane of the type known as *Ukh* in Northern India this mill was capable of dealing with about 30 tons of cane per day, and gave an extraction of 66 per cent. The juice passing from the mill, after careful straining, was limed just short of neutrality. It was then passed through a juice heater, where the temperature was raised rapidly to 180°F. and then passed into the subsiding tanks. From the subsiders the juice was drawn into the eliminators where it was again rapidly heated by exhaust steam until albuminoid matter was coagulated. The juice from the eliminators passed through a bag filter and the

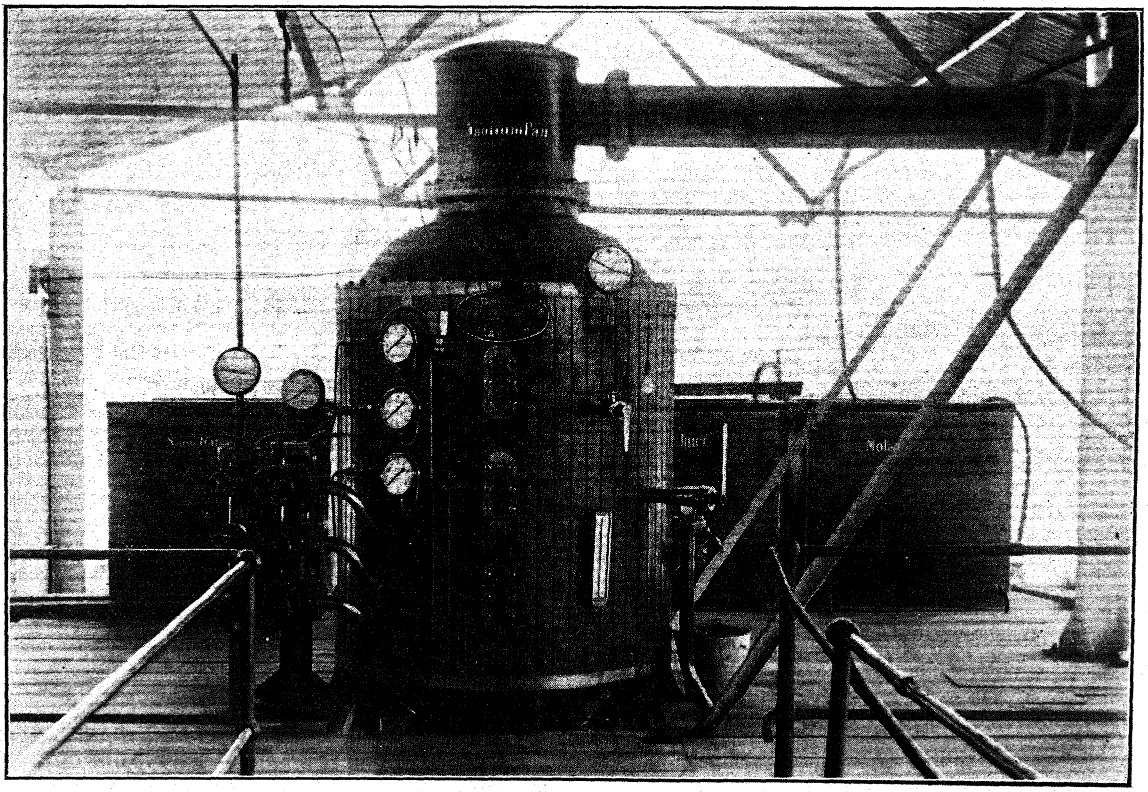
clear juice so obtained passed direct to the vacuum-pan supply tank. In the vacuum-pan the juice was evaporated, using a Torricellian vacuum, to crystallization point and the "grain" built up in the usual way. The "massecuites" obtained was dropped from the vacuum-pan into a rotary crystalliser from whence it passed to the pug-mill and centrifugal. In order to produce finely ground and dry sugar, the factory was also provided with a sugar-dryer, grinder and sifter. Plates XXXV, XXXVI and XXXVII.

It will be seen from the above description that the factory differs from an ordinary central factory only in size and in the omission of the usual "triple effect" intermediate evaporator. It was demonstrated throughout the exhibition that a small factory of this description could work efficiently and regularly without any intermediate evaporator. As, however, dilute juices were taken direct into the vacuum-pan, considerably more care than usual was necessary in boiling, and the time occupied in preparing a panful of massecuites was necessarily comparatively longer. Whilst fully recognising the increased heat economy obtained by the use of *triple effect*, the makers of the plant decided to omit this as they did not consider that a commercially efficient evaporator of this type could be fitted to a factory dealing with less than 4 tons of sugar per 24 hours.

The factory now described was considered to be the smallest possible, and this particular size was chosen because it will deal with an area—say $1\frac{1}{2}$ acres per 24 hours—which can easily be obtained within a reasonable radius in any good cane-growing district.

It was found that a sugar suitable for direct consumption could be produced at a single operation without using any other clarifying agent than lime. By careful boiling a fine crystalline sugar, corresponding very nearly with Bareilly *khand*, was obtained, which commanded a ready sale. By drying and crushing, a fine granulated sugar, corresponding very nearly in appearance with native *bhura*, was obtained. No difficulty was experienced in regard to colour. It is, of course, universally recognised that the separation of large crystals from massecuites is more efficient

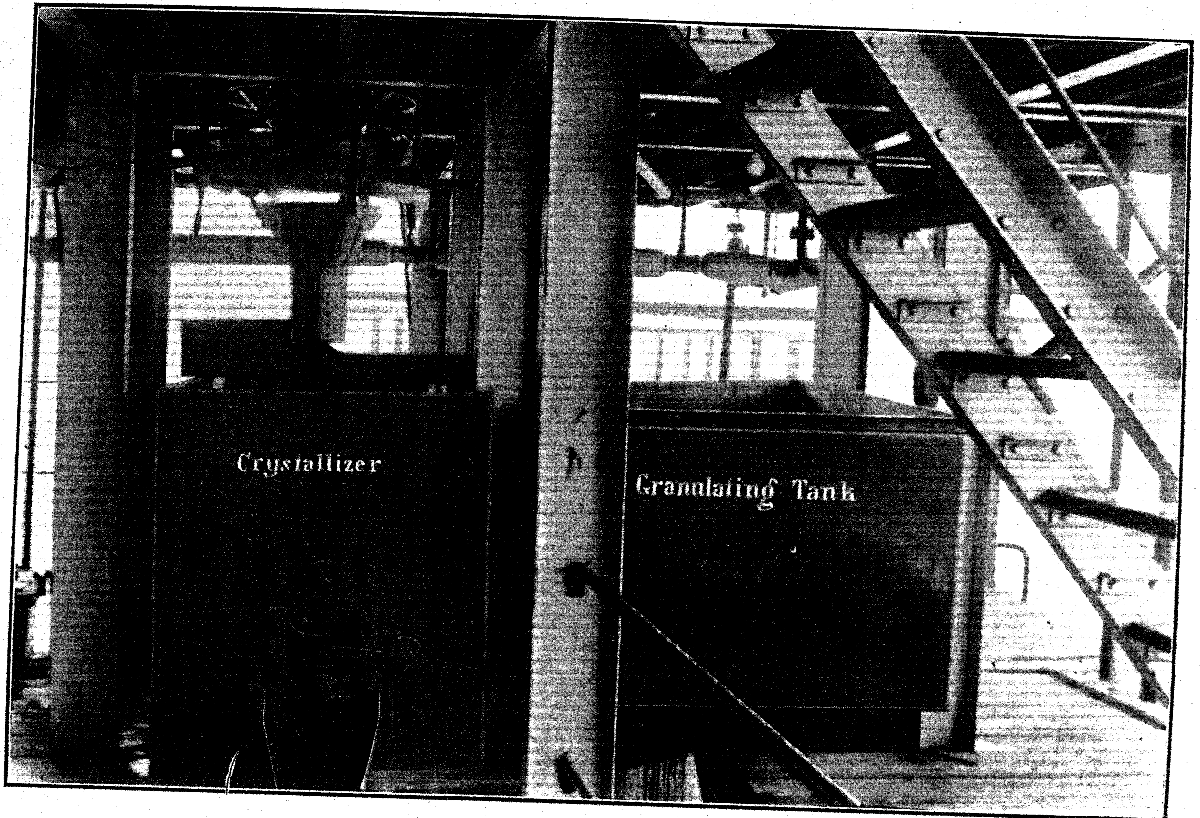
PLATE XXXIV.



A. J. I.

VACUUM PAN.

PLATE XXXV.



A. J. I.

Crystalliser and Granulating Tank.

than the separation of smaller crystals, and in commercial practice each factory owner would have to decide for himself whether to sacrifice quantity to quality, or, in other words, whether to boil a large or a small grain. In boiling a small grain much more sugar passes through into the molasses ; this can be recovered in the second or molasses sugar, and it was found that by careful boiling a molasses sugar of good quality and colour could be obtained. The whole of the steam for the factory was obtained from a single boiler fitted with a special grate for burning megass. Under favourable circumstances no other fuel was required.

II.—Efficiency of the Sugar Recovery.

The only possible way of judging the efficiency of a sugar factory is by determining what percentage of the sucrose entering in the factory in the form of cane or juice is recovered as marketable sugar. A short test of this description covering two full days working from cane and the subsequent boiling of a second sugar from the molasses was carried out after the close of the exhibition. Owing to the short time at our disposal it was decided to determine the percentage of sugar recovered from the juice. No chemical examination was made of the efficiency of the cane crushing mill. On the first day 2,313 galls. of juice containing the 4,096·3lbs. of sugar were supplied to the factory from which 1,938¼lbs. of first sugar was recovered equal to 47·3 per cent. On the second day 2,163 galls. of juice containing 3,400·2lbs. of sugar were supplied from which was obtained 1,897·5lbs. of first sugar equal to 55·8 per cent. From the mixed molasses aggregating approximately 415 galls. and containing 2,512lbs. of sugar 979lbs. of second sugar were obtained equal to 13·06 per cent. of the total sugar entering the factory as juice.

The total recovery of marketable sugar is 64·23 per cent. of the sugar in the juice, or since the 1st and 2nd sugars polarised 98·4 and 98·0 respectively, sucrose recovered as—

1st sugar	1st day	47·3	×	984	was equal to	46·5 %	of sucrose present in the juice.
1st ,,	2nd day	55·8	×	·984	,,	54·9 %	,, ,, ,, ,,
2nd ,,	(total)	13·06	×	·98	,,	12·80 %	,, ,, ,, ,,
1st ,,	average	51·17	×	·984	,,	50·35 %	,, ,, ,, ,,
Total recovery		50·35	+	12·8	,,	63·15 %	= efficiency factor.

SUGAR LEFT IN MOLASSES.

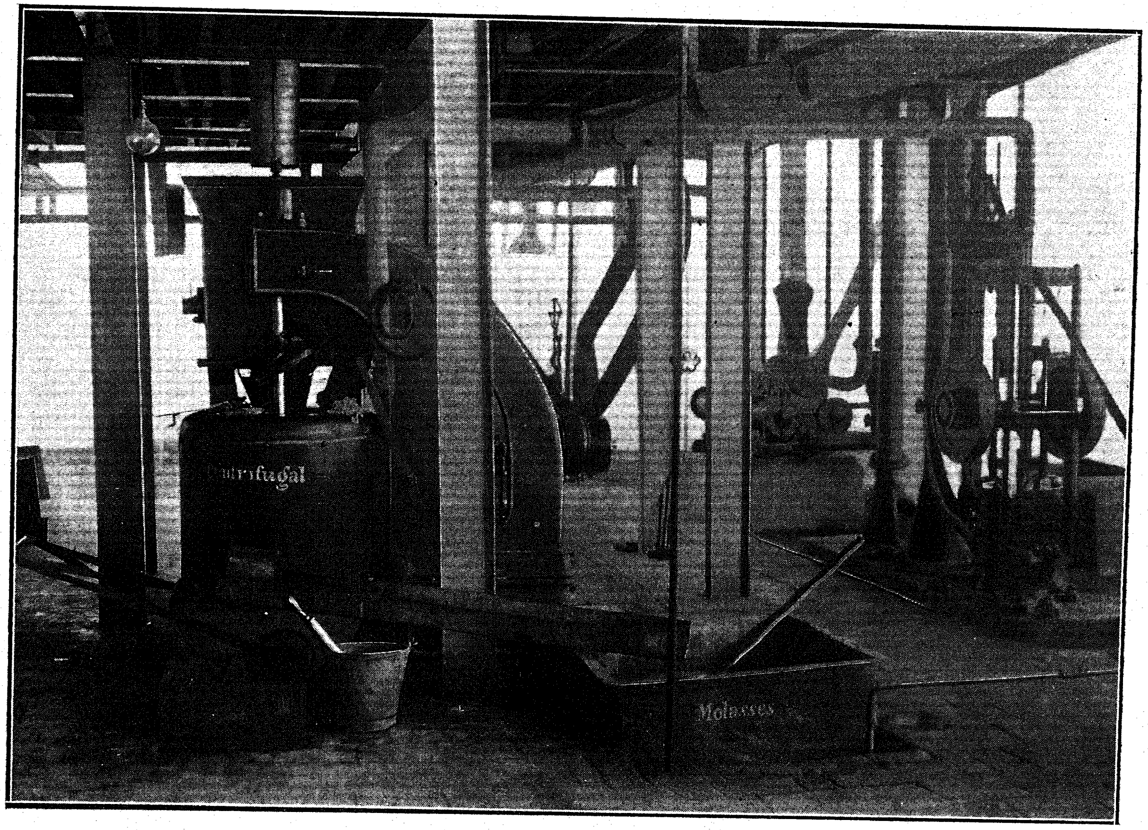
On the first day 234 gallons of molasses containing 1,547·6 lbs of sucrose were produced, corresponding to 37·8 per cent. of the sucrose entering the factory, leaving 100 – 37·8 – 46·5 equal to 15·7 per cent. manufacturing losses.

On the second day 181 galls. of molasses containing 965·3 lbs. of sucrose were produced equal to 28·4 per cent. Loss in manufacture, 100 – 54·9 – 28·4 equal to 16·7 per cent.

On the average of two days of 7,496·5 lbs. of sucrose supplied as juice, 2,512·9 lbs. or 33·5 per cent. was left in the first molasses, of which 12·8 per cent. was subsequently recovered, leaving 20 per cent. in the *exhausted* molasses.

There is a marked difference in the recovery of first sugar on the first and second day, and it will be noted that this is entirely in the recovery of sugar from massecuites. This is due to different systems of boilings adopted on the two days. During the first day's trial the factory manager asked permission to work by the process known as "seeding" in which a small (weighed) quantity of crystals is introduced into the vacuum-pan in order to promote crystallisation; this is a method in common use when sugars for direct consumption are made. It did not, however, in the present instance give such good results as the ordinary method of 'graining' in the pan. As two days' work barely gave enough molasses for the preparation of a second sugar, it was not possible to work up the two lots of molasses separately, and consequently it is not possible to state what the efficiency of the factory would have been, had the second day's efficiency in production of first sugar been maintained for both days. If we assume that the efficiency of the second sugar recovery remains unaltered, we obtain 54·9 plus 12·8 equal to 67·7 per cent. instead of 63·15 per cent. This assumption, however, is hardly justified since with a poorer molasses, the percentage of second sugar recovered would fall and the truth probably lies between the two. Probably we are not far wrong in taking the figure 66 per cent. as the efficiency factor of the factory, 16 per cent. as loss in manufacture and 18 per cent. of

PLATE XXXVI



A. J. I. TO THE LEFT IS SEEN THE CENTRIFUGAL; TO THE RIGHT THE VACUUM PUMP AND THE INJECTOR PUMP; IN THE BACKGROUND THE MAIN ENGINE.

sugar left in the exhausted molasses. For the analyses on which these figures are based, I am indebted to the Agricultural Chemist to Government, U. P., who kindly placed an assistant at my disposal for the purpose and checked the final analytical figures. The analyses themselves are given in Appendix A.

In a recent article* Clarke and Banerji have compared the results obtained with the Hadi process with those obtained in central factories in different parts of the world. For convenience these results together with those obtained above are tabulated below.

TABLE A.

Comparison of the efficiencies of different processes of boiling and clarification.

Sucrose recovered per 100 sucrose in Juice in—	Hadi process open pan boiling (Allahabad.)	West Indian Muscovado process open pans.	Hawaiian factory triple effect vacuum evaporation & carbonation.	West Indian central factory evaporation in vacuo.	Results of 95 factories in Java 1907.	Blair, Campbell and McLean's factory, 1911.
First Sugar ...	39·9	67·75	89·91	72·4	89·91	54·9
Second Sugar ...	15·5			9·9		11·1
Molasses ...	19·6	17·75	5·36	11·9	9·25	18
Inverted and destroyed in manufacture ..	19·2	14·50	3·55	4·6	0·84	16
Scum and waste ...	5·8		1·18	1·2		
	100·0	100·0	100·0	100·0	100·0	100·0
Efficiency factor (per cent. total sucrose recovered)	55·4	67·75	89·91	82·3	89·91	66
First sugar recovered per cent. cane.	4·10 (Pol. 95·1)	7·15 (Pol. 90·0)	10·40 (Pol. 96·5)	8 60 (Pol. 96·5)	10·09 (Pol. 97·8)	5·76 (Pol. 98·4)
Second sugar recovered per cent. cane	1·76 (Pol. 86·9)	....	3·19 (Pol. 90)	1·26 (Pol. 90)	....	1·21 (Pol. 98)
Total sugar ...	5·86	7·15	13·59	9·86	10·09	6·97

From the above table it will be seen that, as compared with the Hadi process (the only Indian process for which figures have been published) 15 per cent. more sucrose is recovered as first sugar

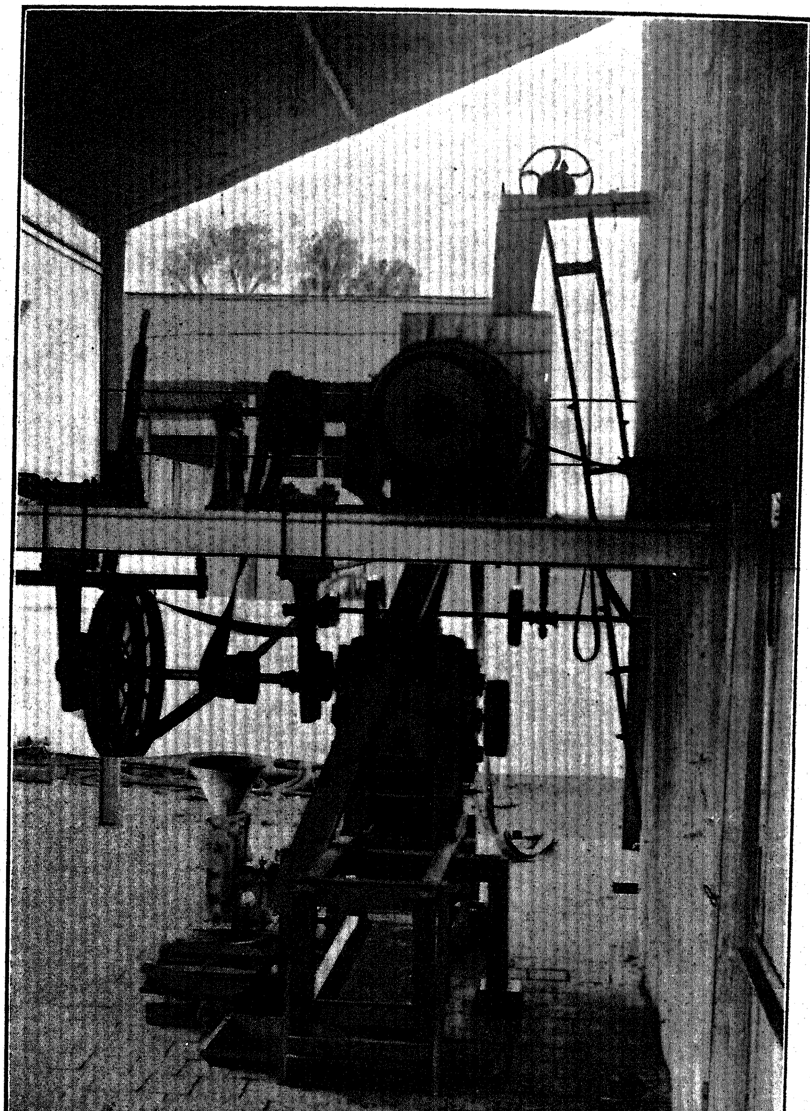
* Clarke and Banerji. The efficiency of the Hadi process of sugar-making. *Agricultural Journal of India*, Vol. V, page 39.

(polarising 98·4 as against Hadi's 95·1), the factory efficiency factor being 66 as compared to 55·4. The sugar left in the molasses is 18 per cent. as against 19·6, and the amount lost in scums and destroyed in manufacture, 16 per cent. as against 25. This will be admitted to be a considerable step forward, especially as the sugar produced finds a ready market.

A reference to the table shows, however, that these results do not compare so favourably with those obtained in large central factories in other parts of the world. How far this is due to the factory itself and how far to the quality of cane used is difficult to say. A reference to Appendix A will, however, show that the juices obtained at Allahabad contained a very high percentage of glucose, the average glucose content for the first day's working was 2·06 per cent. and for the second day 2·7 per cent. This was partly due to the age of the cane, which had been brought a considerable distance by rail and road, and also to the fact that it was not obtained from a good cane-growing district, nor was it from either of the best varieties of U. P. canes.

A word or two of criticism as to the figures given in the above table for the Muscovado process will not be out of place. These were taken from a paper by Douglas written with the object of showing the possibilities of central factories in Barbados, and he has consequently given the best obtainable results for the Muscovado process. The cane juices obtained in Barbados are recognised to be unusually pure, and several contemporary writers have attributed to this cause the fact that the Muscovado process lasted in Barbados long after it had been replaced by modern central factories in the neighbouring colonies of Trinidad and British Guiana. With impure juices the Muscovado process gives a much lower sugar recovery. It does not differ in any *essential* detail from the Indian *khandsari* process. It may be added that the Muscovado process produces sugar of a very low purity (polarising 90 per cent. and under) which has no counterpart in the Indian market, and which further loses weight considerably by drainage. This explanation is necessary as the figures given in the table would otherwise lead to the erroneous

PLATE XXXVII



A. J. I. THE SUGAR ELEVATOR, DRYER, GRINDER AND SIFTER.

conclusion that the Muscovado process is much more efficient than the Hadi process and about as efficient as the small plant described in this note.

With reference to the figures quoted for larger central factories, it has already been noted that these are largely influenced by the purity of the juices worked with. It should also be remembered that most of these factories turn out a large proportion of their sugar in the form of refining crystals and not as white sugar for direct consumption, thus increasing the *apparent* efficiency of the sugar recovery. It is, of course, not contended that in a small factory of this description the same efficiency can be obtained as in a large central factory.

Lack of time prevented any detailed chemical examination of the different stages of the process. The results, however, although they must be accepted with some reserve as already explained, indicate roughly in what direction further improvements are possible. The percentage of sugar lost in manufacture was very high for a modern plant, and there is some reason to believe that a considerable quantity of this was due to mechanical losses in the scums. With purer juices less sugar would be left in the molasses.

Percentage of sugar recovered from the cane.

The figures given above are based on an exceedingly short trial covering only three days' working, and, consequently, are given with some reserve. In view, however, of the fact that conditions at Allahabad were uniformly less favourable than would be obtained in normal working in a good sugar district, they may probably be considered to be on the safe side. No direct tests having been made as to the recovery of sugar from the cane, it is with some hesitation that one expresses any opinion on this point. Assuming, however, an extraction of 66 per cent. (which was obtained in actual practice as an average of two tests) and a juice containing 16 per cent. by weight of sucrose (average of the second day's working was 16·29 per cent.), this corresponds to 6·97 per cent. of sugar recovered from the cane. This figure

is fortunately confirmed by a previous test in which the cane entering the factory and the sugar produced were carefully weighed, although no analytical control was possible at the time, and in which as a result of four full days' working a recovery of 7 per cent. on the cane was obtained. In actual factory practice this figure will vary considerably with the quality of cane obtained, but the figure given above indicates approximately what may be expected. With careful cultivation and selection of only ripe canes for manufacture considerably better results are possible. Too much stress cannot be laid on the importance of pure juices to a factory, for the losses of sugar during manufacture due to the presence of glucose and salts in the juice, and hence in the massecuites, are generally recognised to be exceedingly heavy. It has been shown, however, by Clarke* that with proper cultivation and harvesting exceedingly pure juices can be obtained from some varieties of indigenous canes. While it is doubtful how far the exceedingly pure juices obtained by him on an experimental scale could be reproduced on a commercial scale, there is every reason to believe that Indian canes with proper cultivation can produce juices not inferior to the world's average in sugar content and purity.

III.—Financial Results.

When the exhibition factory was arranged for, it was hoped that it might be possible to publish a balance sheet for the season's working, which would give a fair account of what might be expected from a small modern factory. So many disturbing factors, however, arose in working the factory purely for exhibition purposes that any such balance sheet would be misleading. To mention only three of these: (1) cane cost double as much as it does in a sugar-growing district and reached the factory stale, besides often being inferior in quality; (2) the price of labour during the exhibition was exceedingly high, and (3) the necessity of providing demonstrations at suitable hours every day made it impossible to work the full twenty-four hours under

* Proceedings of the Agricultural Conference, Allahabad, January, 1911.

normal factory conditions. The tentative statement given below, however, is based on the experience obtained at Allahabad :—

	Rs.	
Capital Cost—		
Cost of the plant and staging	36,000	
Cost of erection about	2,000	
Cost of buildings (variable)	4,000	
		42,000
Working capital (= cost of season's cane)	12,000	
Miscellaneous	1,000	
		55,000
Interest and depreciation and maintenance on Rs. 42,000 at 20%	8,400	
Interest on Rs. 13,000 at 8%	1,040	
Cost of cane for 80 days' working at As. 4 per maund ...	11,760	
Supervision and skilled labour at Rs. 760 p.m. for three months	2,280	
Labour at Rs. 200 p. m.	600	
Contingencies at Rs. 100 p. m.	300	
		24,380

80 working days at 40 maunds per day = 3,200 maunds of sugar; consequently the cost of production of one maund of sugar is Rs. $\frac{24380}{3200}$ = Rs. 7-10. In addition about 1,000 maunds of molasses would be produced for which there is usually a ready market.

The supervision charges are calculated as follows :—

	Rs. p. m.
European Manager (who would be a trained sugar boiler) ...	350
Assistant Manager (Indian)	100
2nd Assistant (Indian)	60
Skilled labour—two mechanics at Rs. 30 each	60
Two stokers at Rs. 15 each	30
Four filter and centrifugal men at Rs. 15 each	60
Clerk	
Weighman	15
	760

Similarly, if the price of cane is As. 5 per maund, the cost of production of one maund of sugar rises to Rs. 8-8-6 per maund and with cane at As. 6 per maund to Rs. 9-7-4 per maund. No assumption has been made so far with reference to the selling price, but assuming that sugar fetches Rs. 10 per maund and molasses Rs. 2 it is obvious that the factory can show a reasonable profit for its season's working even with cane at As. 6 per maund. Cane is frequently available in these provinces at As. 4 per maund

or less, but it must be remembered that with an outturn of 400 maunds per acre, which is probably a fair average, this yields only a moderate profit to the grower and one which would not invariably induce him to grow cane for a factory. On the other hand, a factory paying As. 6 per maund would probably find that cane cultivation in the vicinity would increase.

A liberal allowance has been made for working capital and for interest on the same terms as advances have usually to be given to secure the cultivation of any considerable area of cane. When advances are made, the cane is, of course, purchased cheaper. In the above statements I have only assumed a working period of 80 days or including stoppages three months. It should be possible by judicious arrangement of the cane supply to arrange for a working season of 100 days; this depends on circumstances beyond the control of the factory manager, and the question of the selection of early and late ripening varieties of cane is all-important in this connection.

The main difficulty, however, in running a factory on these terms is that the staff is only employed for three months in the year. Equally of course depreciation and interest has to be paid on the plant and capital for a whole year. This is a difficulty that occurs in all cane-sugar factories, but is accentuated in these provinces where the possible cane harvest is shorter than in almost any other sugar-growing country. The effect of this as regards depreciation has already been allowed for, but practical difficulties occur in the case of the staff. A European manager is at present a *sine quâ non,* and if he is to be retained from year to year, it would be necessary at least to pay his return passage to England, his pay on the voyage and probably a small retaining salary. This would be practically equivalent to three months' salary. A similar difficulty arises as regards the Indian assistant managers. Under these conditions, therefore, supervision charges would be raised by about 1,000/- to 1,500/-, raising the cost of production by from 4 to 6 per cent. At present, however, an alternative offers. Sugar can be made in the off season from *gur* provided that a supply of *gur* is obtainable at a reasonable price

and of a suitable quality. *Gur* of good quality for sugar-making was available during the present year at Rs. 3 per maund landed at Allahabad or Cawnpore—in some districts it was considerably cheaper. Actual experiment with about 10 tons of *gur* showed that the factory as it stood was capable of handling *gur* economically. For regular working one or two minor additions for convenience sake would be necessary. From the *gur* used about 40 per cent. by weight was recovered as marketable sugar. Thus *gur* at Rs. 3 per maund corresponds roughly to cane at As. 8, a price which the factory could afford to pay if it could work most of the year.

Gur as a starting point for sugar-making is admittedly scientifically unsound; the loss of sugar during the manufacture of *gur* is very high indeed, and it is at the best an indifferent material for sugar-refining. It has, however, the advantage of being available in large quantities, can be transported for considerable distances and can be stored. The price of *gur* in the Indian market apparently bears little relation to the price of imported sugar, or to its own sugar content; the higher-priced *gurs* prepared for eating purposes are so dear in proportion to their sugar content that they are entirely useless for refiners who require *gur* that has been limed in preparation. Nevertheless from statements made by land-holders in the U. P. visiting the factory at Allahabad, it appears probable that, for some years to come at any rate, many of them will be in a position to obtain *gur* for refining purposes at reasonable rates, and this affords a method of employing the factory and its staff for the greater part of the year. The following statement gives an approximate estimate of the cost of working a factory with *gur* during the off season :—

	Capital cost. Rs.
Plant and staging as before	36,000
Erection ,, ...	2,000
Buildings ,, ...	4,000
Extra plant for handling *gur*	1,800
Working capital	20,000
	63,800

	Rs.	
Establishment (as before) Rs. 760 per mensem ...	9,120	
Labour Rs. 200 per mensem	2,400	
		11,520
Interest and depreciation, and maintenance on Rs. 43,800 at 20 per cent.	8,760	
Interest on 20,000 at 8 per cent.	1,600	
Repairs and miscellaneous expenses	1,000	
		11,360
Purchase of cane, 80 days' supply, at As. 6 per md ...	17,140	
Purchase of *gur*, 200 days, at Rs. 3-12 per md. ...	75,000	
Fuel in addition to megass (for *gur* working only)	3,000	
		95,140
		1,18,020
INCOME—		
Sugar from cane, 40 mds. per day, 80 days. 3,200 mds. at Rs. 10	32,000	
Sugar from *gur*, 40 mds. per day, 200 days, 8,000 mds. at Rs. 10	80,000	
Molasses, 8,000 mds. at Rs. 2	16,000	
		1,28,000

Nett profit after paying interest and depreciation Rs. 10,000.

In this estimate it will be noticed that I have taken high rates for both cane and *gur*; with cane at Rs. 4 and *gur* at Rs. 3, the profits would be increased by Rs. 20,000. On the other hand, a reduction of the price of sugar to Rs. 9 per maund with cane and *gur* both dear would mean that the factory would only just pay expenses, interest and depreciation. This combination is unlikely, but would have to be faced in individual years. It must also be admitted that unless both *gur* and cane were cheap, the factory could not possibly compete with imported sugar. With cheap cane, cheap *gur* and advantage of being near its customers it might just do so. With *gur* at Rs. 3 and cane at As. 4 the working expenses would be Rs. 97,640. If sugar sold at Rs. 8 per maund, there would be a profit of Rs. 8,000 (after paying interest and depreciation) provided that the molasses market held good.

It has been the custom in certain quarters to estimate the possibilities of factories by calculations based on the present price of *desi* sugar (about Rs. 12 per md.). That some small

factories do obtain these prices is undoubted, but it is also a fact that large factories working in Behar obtain much lower prices. If the sugar industry in India is to extend, it will be by replacing sugar at present imported. There are a number of consumers willing to pay higher prices for *swadeshi* produce and others apparently who are willing to pay an intermediate price for sugar made in India, but who are not willing to pay the high price at which sugar produced by the old *khandsari* process is sold. Any factories, however, starting in the near future will apparently obtain a considerable advantage for some time, no small matter if it enables them to pay off their capital liabilities before severe competition sets in.

In conclusion, it may be stated that the results given in this report can only be treated as a first approximation. Messrs. Blair, Campbell & McLean have shown that there are no great practical difficulties in constructing a small factory capable of dealing with the produce of 100 acres per annum, and that without using any chemicals, or any process objectionable to the most orthodox Hindu, a sugar suitable for direct consumption and commanding a good price can be produced. A short control test has shown that the factory is considerably more efficient than any other factory of its size tried up to the present. The results also indicate in a general manner in what direction future improvements might be expected. Definite conclusions on this point can, however, only be obtained by a season's working under normal conditions and under careful chemical control.

It is, of course, impossible in actual practice that so small a factory should work under chemical control. It would necessarily have to work largely by "rule of thumb." Until, however, the possibilities of the factory have been thoroughly investigated, chemical control is essential.

If small modern factories are to play an important part in the development of the sugar industry in the United Provinces, the question of training suitable men for managers and assistant managers will become a serious problem. At present a European sugar boiler is necessary. Suitable men are not easy to obtain,

are relatively expensive, and they vary very much in capacity for independent work and for controlling labour. There seems, however, no reason why Indians of good general education should not be trained in sugar-boiling and factory management as well as in sugar-engineering. Practical training in a factory would be essential, combined with sufficient instruction in the principles involved to enable factory managers to meet difficulties which call for a departure from the ordinary routine.

In conclusion, it cannot be too strongly emphasised that whilst it has been shown above that a very small factory can be worked at a profit, the largest commensurate with the available cane supply should be installed in every case. The larger the factory, the smaller the proportionate capital cost and the greater the *possible* efficiency and the better the supervision which can be afforded.

The writer wishes to express his indebtedness to the Agricultural Chemist to Government, U. P., who kindly lent an assistant, Babu Har Narain, for the analytical work and to Mr. Hulme representing Messrs. Blair, Campbell and McLean, for the facilities given for the examination of the factory and for the ever-ready courtesy with which any information required has been supplied.

APPENDIX A.

Analyses of cane juice.

1st day No.	% sucrose in juice.	% glucose in juice.
1	15·70	2·48
2	16·12	2·28
3	16·70	1·88
4	17·12	1·62
5	17·02	1·71
6	16·94	1·87
7	16·92	1·88
8	16·62	1·78
9	16·53	2·03
10	16·87	1·81
11	15·83	2·30
12	15·82	2·57
13	15·77	2·32
14	16·32	1·90

APPENDIX A.—(*Continued.*)

Analyses of cane juice—(Continued.)

1st day No.	% sucrose in juice.	% glucose in juice.
15	15·68	2·46
16	15·49	2·45
17	15·27	2·12
18	16·43	1·68
2nd day 19	16·33	1·91
20	15·91	2·02
21	16·00	1·96
22	15·40	2·36
23	15·35	2·41
24	15·68	2·33
25	15·96	2·35
26	15·63	2·43
27	15·96	...
28	15·19	2·71
29	14·70	3·71
30	14·06	3·56
31	14·22	3·26
32	13·56	3·39
33	13·87	3·48
34	14·02	3·41
35	14·08	3·52
36	13·45	3·82

DIFFICULTIES IN THE IMPROVEMENT OF INDIAN AGRICULTURE.

By M. E. COUCHMAN, I.C.S.,

Director of Agriculture, Madras.

At the sixth Annual Session of the South Indian Association, Madras, Mr. M. E. Couchman, I.C.S., Director of Agriculture, Madras, read a paper on "Difficulties in the Improvement of Indian Agriculture." He said :—

"The object of this paper is to allay the impatience which finds occasional expression that more rapid progress is not being made in the improvement of Indian agriculture. This criticism comes from the educated classes. The general attitude of the agricultural classes towards the department is still that of the landholders of another province, who, when summoned to meet the head of the province in conference and asked what their wants were in agricultural matters, replied more land, more water, and to be left alone by the Government.

"I have, therefore, taken advantage of your invitation to place before you as the representatives of the educated classes of Madras some of the reasons why progress in the introduction of agricultural improvements must always be slow, and especially so in India.

"In doing this, I shall not dwell upon the ordinary administrative difficulties which impede all branches of Indian administration and especially those which seek to remove long-standing prejudices or to change old customs and have to rely only on persuasion to achieve their objects. You are familiar with all these difficulties. You know the dislike and suspicion of official interference which are still so strong in the villages. The Tamil proverb that a village which is often visited by the king will

never prosper, is still representative of the ideas of the average villager. It is easy to make too much of these difficulties; although we have but a very small establishment as yet, we find that a properly trained and sympathetic subordinate who really knows his business can, without very much difficulty, gain the ear of the cultivating classes and persuade them to try our suggestions, provided he has some real improvement to recommend to them. The difficulties which I shall try to describe to-day are those of general application fundamental to the subject.

"In Tolstoi's great book, Anna Karenina, there is a vivid description of the various hindrances that an educated man meets with when he tries to influence his tenants to adopt what seem to him more up-to-date methods of agriculture.

"Constantin Levin bought a hay-making machine. The man who drove it disliked the long arms of the machine waving over his head, and took steps to put it out of order. He bought English ploughs, but his peasants broke them because they were too lazy to lift them up when turning at the end of the furrow. He imported English cattle but they were suffered to die for want of ordinary attention. He set apart a portion of a field for seed, but his men cut this before it was ripe, because it was the easiest to cut. In another of his books Tolstoi lays his finger on the right place, when he says that an agricultural reformer must first study the mind of the peasant, because this is the most important of all agricultural conditions, and it is this which we must study before we consider the other elements of the problem.

"Superficial observers in all countries are in the habit of deriding the farming classes as ignorant and obstinate, blindly following the obsolete practices of their forefathers and inasmuch as farmers seldom write books, judgment goes against them by default. I should like you to consider for a moment why it is that farmers as a class are more conservative than the rest of the world and whether they are wrong in being so.

"A farmer is brought up on the land from his earliest days. Year after year he witnesses the same majestic procession of the seasons. The same crops are sown and harvested at the same

times. Every act of his life is guided by the regular and unvarying movements of nature, and the farmer himself may be said to be a part of nature's system. It is far otherwise with the physician, the lawyer and the merchant. They have necessarily to study the fickle thing by whose favour they live,—human nature with its thousand varying moods and fancies. Their minds are, therefore, necessarily always on the alert for signs of change. One year a doctor must, if he wishes to be popular, recommend the operation for appendicitis. Another year he must insist on the virtues of the Bulgarian milk bacillus. The piece-goods merchant knows that the pattern which sold last year may be out of favour this year. There are so many lawyers here that I should be afraid to give specific instances from that profession, but I believe I am right in saying that different clients require different handling and, with due respect, the same may be said of the judges themselves. It is, in fact, our occupations which mould our characters, and the occupation of a farmer is such as to make him a conservative. Looking into the matter more closely, we must admit that very often change is uncalled for in agricultural methods. It is contrary to human nature to expect the average man to incur exertions in excess of what suffices for his needs. So long as he can live comfortably on the scale demanded by his standard of living, there is no need for change. Life in many parts of India is still so simple that over large tracts there is no call for agricultural improvement. The need for improvement only arises because even the remotest villages are connected up with the outside world, which is always changing.

"To foresee the need for change, to recognise the slight indications which herald its advent, requires not only a scientific training but very special gifts of insight and imagination. A common error is to suppose that because the peasant gives an absurd reason for rejecting a proposed change in his methods, his opposition to it is irrational. He may know by instinct that the suggested improvement is no improvement at all, because it is out of harmony with his general system of cultivation, but he

would never be able to express this idea and hence gives the first reason which comes into his head. Most of the critics of the farmer's conservatism are ill-equipped for the task of setting him right, and every language probably has old stories, the moral of which is that the man who listens to his neighbour's advice comes to a bad end.

"One difficulty, then, common to all countries is that the farming classes are necessarily conservative and are usually right in being so. When, therefore, we have a real improvement to put before them they are apt to turn a deaf ear.

"This difficulty is present in a special degree in India where not only are all classes more conservative than in the West, but the separation between the educated classes and the agricultural classes is more complete than elsewhere, resulting in a want of knowledge on the one side and of confidence on the other. The agricultural department has a double task to overcome this difficulty. It has to try to interest the agricultural classes in education and the educated classes in agriculture.

"Only second to the difficulty of overcoming the conservatism of the farmer comes the difficulty of finding improvements which can be safely recommended to him. Occasionally the example of the agricultural departments of other countries is held up to us for imitation. It should be remembered that the agricultural department of a country like America or Africa has an easy task before it compared with ours. In those countries the farmers are still opening up virgin land, or only just beginning to feel the need for intensive cultivation. The experts of the department have the experience of older countries to guide them in their work. The farmers of new countries are many of them not professional farmers at all but adventurous spirits who have been attracted to the new country by a love of adventure or the hope of making a fortune. They are, therefore, in need of advice and are anxious to have it. Moreover, the ailments of youth are easier to cure than those of age. The agricultural experts of those countries may be compared to physicians treating a child for a case of measles. In India we are prescribing

for a patient of advanced age suffering from general debility. The farmers of this country have behind them the experience of thousands of years of cultivation and have therefore learnt all that actual experience can teach them. There is nothing new in this country. We have lately been told that even aeroplanes were known in India long ago. It is a fact that painful experience has already taught nearly all that there is to learn about the seasons and the management of the soil, though by no means all the cultivators follow their better judgment. This knowledge is unevenly distributed, and one task of the department is to introduce good practices from one part of the country into another. Another field of work, of course, lies in those matters where physical science has discovered facts which the experience of practical farmers could never come across. The field of possible improvement is, however, far narrower than in new countries and progress must, therefore, be slower. I may, however, point out that in countries where politics enter into agriculture, the reports of the agricultural department cannot safely be taken at their face value. We do not know what the farmers of those countries really think about them. Another very important point the force of which will be felt more and more, as soon as we have come to the end of the few obvious improvements which can be discovered without any research, is that all scientific agriculture, and all agricultural literature up to the last few years, deals with the agriculture of temperate climates, and is founded on research work done outside the tropics. Hence in India we have to throw away almost all our knowledge of applied agricultural science, and fall back on first principles, and work out our proposed improvements from the beginning. For example, many of the methods, which farmers follow in England for cleaning the land and preparing the soil to receive the seed, are based upon the effects of the severe European winter, and quite different methods have to be worked out here. As regards research, the number of scientific men in India is so small and so much of their time is at present taken up in work of organisation and teaching that little time remains for research. We must have patience till we have

produced an Indian school of agriculture with a numerous body of workers. It is seldom that any great discovery is made at one step by one man. The competition and co-operation of many men devoted to the same studies is necessary before much progress in agricultural research can be expected. We must learn before we can teach. Many years of research and experimental work will be required before we can fully understand the agricultural practices of Indian cultivators, and till we do understand them, any improvements we may be able to make in them will be due more to good luck than to a solid foundation of real knowledge.

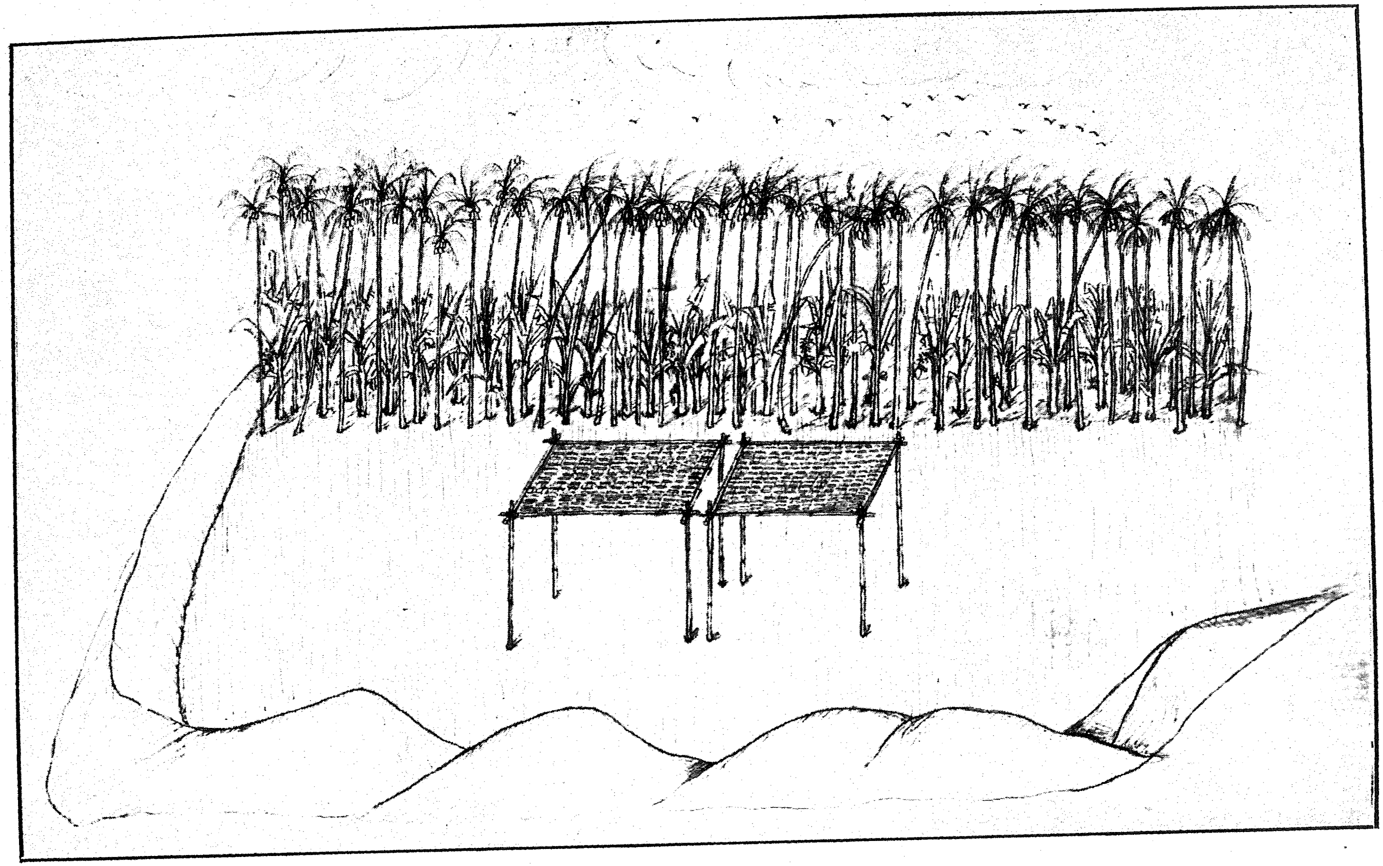
"I may then sum up the chief difficulties which hamper the progress of agricultural improvement, as, first, the want of knowledge regarding Indian agriculture. Second, the fact that in India so much practical knowledge has already been discovered by the experience of generations that there is less scope for a rapid advance than in new countries; and thirdly, that the Indian cultivator possesses in an intensified form the conservatism of the farmer common to all countries, and that, owing to the separation of classes here, the difficulty of breaking down that conservatism is greater here than elsewhere. The last difficulty, however, is the least of the three. Our experience is that the Madras cultivator is by no means unwilling to take up a new thing if it is really an improvement. The rapid spread of Cambodia or American Cotton in Tinnevelly, Ramnad and Madura districts in the last few years is a most encouraging sign that a really good new crop can be introduced very rapidly.

"For introducing such improvements as can already be safely recommended we need more trained men. To remove the difficulty of want of knowledge, we want more workers in the field of research. Ample facilities have been provided for both purposes at Coimbatore. As I have pointed out on a recent occasion, the prospects from a pecuniary point of view are not to be despised, especially when it is remembered that the department is a new and expanding one. For a man of means who is on the look-out for an interesting and useful career I cannot imagine one which has more attractions.

"What I would ask our critics to bear in mind is this. It is far from easy to point to positive improvements suitable for any particular village without knowledge of the locality. We are often pressed to send itinerant lecturers broadcast through the villages, and it is assumed that qualified lecturers are to be had at a moment's notice and that agriculture can be taught by lectures in the same way that law or arithmetic is taught. Agriculture is an applied science, and its application must vary in a greater or less degree with every small variation of local conditions. Lecturers on the general principles of agriculture would be useless to ryots who are not used to deducing their practice from theory. The only thing which appeals to them is definite advice. If a new crop is to be recommended to them, the exact kind of soil suitable for it, the exact time to sow it, the exact method of cultivation must be laid down, and if the advice given is, owing to any special circumstances in the village, impracticable, the cultivator will conclude that his would-be adviser does not know his business and will not listen to him.

"And it is absurd to blame him for this attitude. He cannot afford to engage in an experiment. You will see, therefore, how it is not possible for a lecturer to start to-night from Mylapore and lecture to the ryots of Ganjam on paddy cultivation if he has not been there before and does not know the local practices and seasons. We must in short learn before we can teach, and we must not blame the cultivators if they are somewhat hard to persuade. Time and patience will overcome both difficulties. The essential thing is to avoid giving ill-considered advice which would retard all progress indefinitely."

PLATE XXXVIII.



A. J. I.

Fig. 1.

THE DRYING OF PLANTAINS AT AGASHI.

By L. B. KULKARNI, *L. Ag.*,

Of the Bombay Agricultural Department.

AGASHI is a village in Bassein Taluka, Thana District, Bombay Presidency. It is about twelve miles from Bassein and one mile and a half from the sea. There is a continuous range of hills to the north. Fields of plantains bordered by cocoanuts, are seen to the south of the village. Between the hills and the cultivated lands there is a small plain and on this plain the plantains are dried. The place visited is shown in figure 1. The drying process of plantains begins in October and lasts up to the end of December. During this period the maximum and minimum temperatures are as follows :—

	Max.	Min.
October ...	90°	76°
November ...	89°	70°
December ...	83°	67°

Four varieties of plantains, *viz.*, *Basrai*, *Motheli*, *Welchi* and *Rajeli* are grown here, but all are not used for drying. The special variety dried is *Rajeli*. This variety is distinguished from the rest by the following points. The plant grows about 13 feet high ; it is next in height to *Welchi* which grows up to 15 feet. The plantains are from 6″ to 12″ long. One typical raw fruit is shown in the figure 2. The fruit has three distinct ridges. The pulp is very tough to the touch, and on it there are found six lines. The diameter of the pulp is about an inch. Mr. G. A. Gammie in his "Field, Orchard and Garden Crops of

the Bombay Presidency" (page 72) gives the following description of the *Rajeli* plantain :—

"Robust, stem yellowish green, leaves long and narrow; fruits usually five inches long by 1″ to $1\frac{1}{2}$″ broad; yellow, more or less plano-convex; gradually narrowing to the stalk. Lip contracted with a distinct hard brown beak."

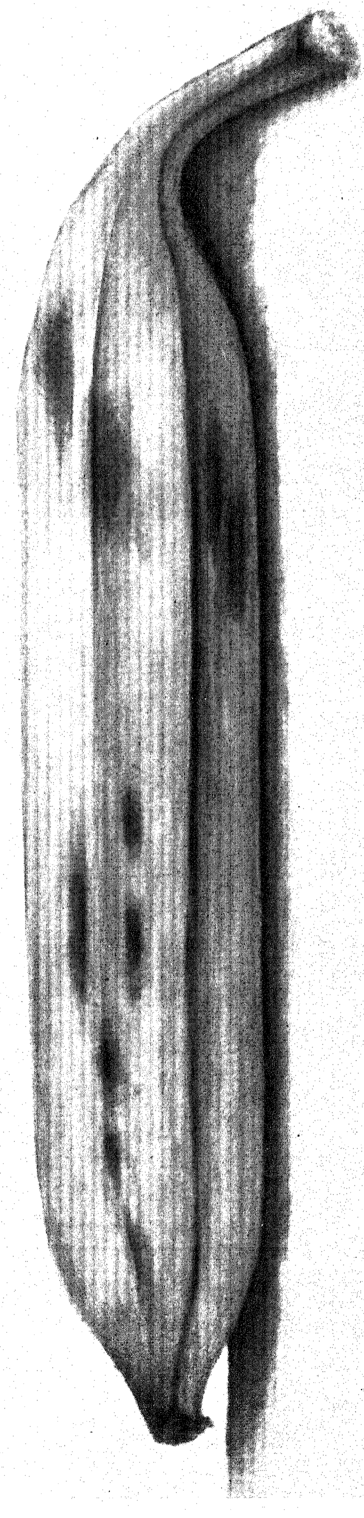
This variety is not treated differently from the others as regards cultivation. The suckers are planted with other varieties in October at 6 feet distance. Water is given twice a week. Castor cake, three pounds per plant is given. The first manuring is generally done after the plants take hold of the soil; the second one month later. The fruits are ready for harvesting in the October of the following year.

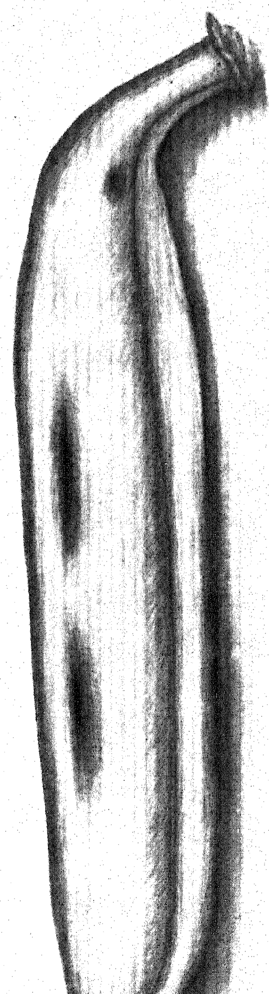
Harvesting.—The heads are removed when the fruits attain their full size. It needs an experienced eye to tell when this stage is reached. The fruits look quite green when the bunches are cut. The newly cut bunches are brought into the houses, and there the peduncles are removed. The small bunches are put in a store prepared by cylinders of a bamboo mat 10′ × 10′ placed vertically. This store is generally in the centre of the house and thus the entrance of air is prevented as far as possible.

On the floor of this improvised store-house rice straw is placed and on it the plantain bunches are spread layer by layer. The topmost layer is covered by plantain leaves to produce heat. One store like this accommodates about 12,000 to 15,000 plantains. They are generally stored in the morning and are taken out after three days. The colour of the fruit is then quite yellow. A typical fruit ready for drying is shown in figure 3. The fruit when ripe is diminished in size.

The ripe bunches are brought in a basket to the prepared ground on the plain outside the village. The ground is made hard by beating it with a wooden plank and then plastering it with cowdung and water. A mat about 6′ × 8′ is spread on the prepared ground when it is dry. Then the plantains are arranged in a line after the skin has been removed. The colour and the appearance of the fruit on the first day is shown in figure 4.

PLATE XXXIX.





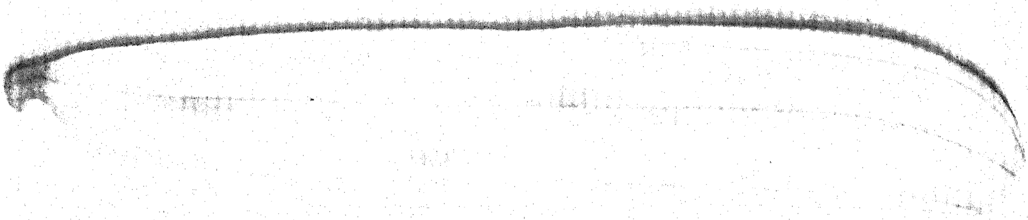


FIG. 4.

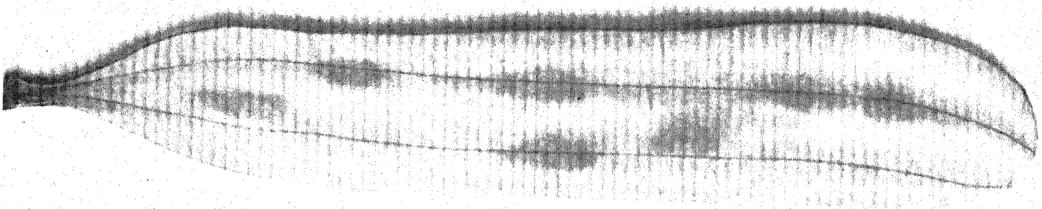


FIG. 5.

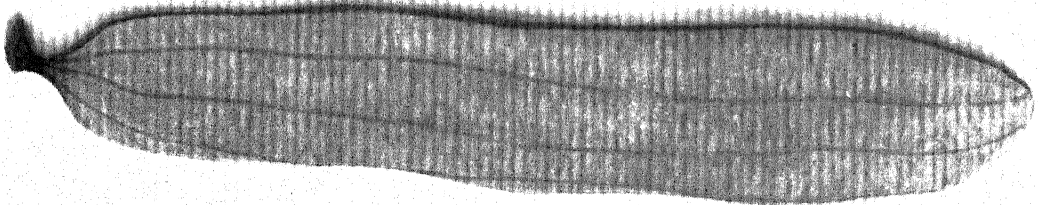


FIG. 6.

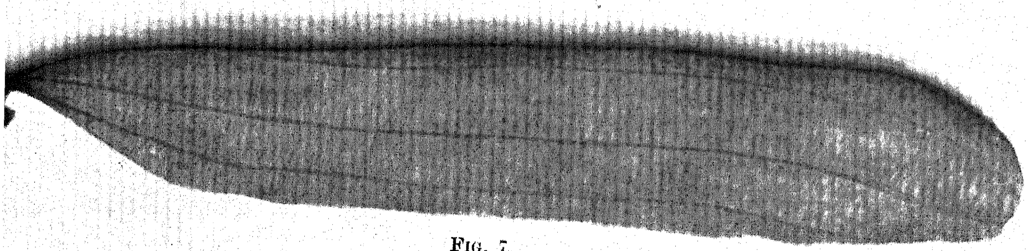


FIG. 7.

I.

Some people dry the plantains on a platform about 10 feet high to avoid the trouble of watching.

After lying all day in the sun the fruits are gathered in a heap in the evening before the cold begins and are left all night covered with dry plantain leaves and a mat. The above processes are repeated for three days and three nights, and on the fourth day the fruits are ready for marketing. The figures 5, 6 and 7 show how the colour changes from day to day. The fruit is, before drying, very hard to the touch, brittle and round; but as it dries, it becomes yielding to the touch, elastic and flattened. It also loses some weight. The fruit tastes sweeter as it dries. It is said that properly dried plantains keep for six months. On the last day of drying the fruits are wrapped in plantain leaves in bundles of a dozen each. The retail rate is about four annas a pound, and the wholesale is $3\frac{3}{4}$ annas according to the quality of the fruit and the state of the market.

The yearly yield of dried plantains from Agashi is estimated at 160 tons, worth about Rs. 27,000. It is said that plantains used to be dried at some other villages than Agashi (Thana Gazetteer, p. 292); but it does not seem to be done nowadays except at Agashi. The reason of this is not known.

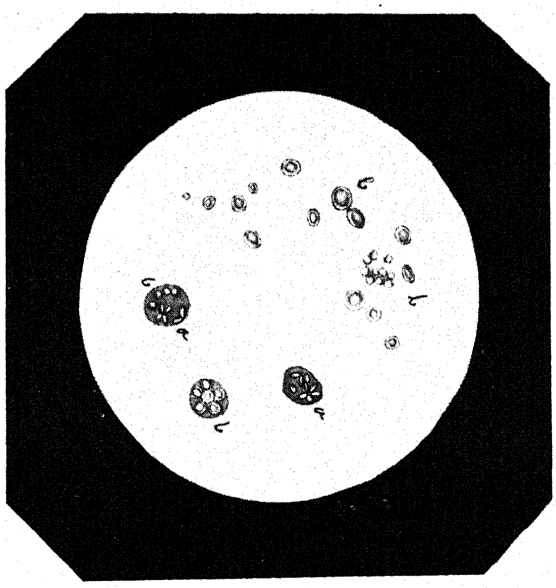
GRASSERIE IN SILK-WORMS.

By M. N. De, M.S.A.,

Sericultural Assistant to the Imperial Entomologist.

Grasserie is a disease of silk-worms causing great damage to rearers. The following few notes on the subject, while they may not bring to light anything new, may be found of some interest. My first experiment was carried on to prove whether the silk-worms are infected with grasserie in their early or in their mature stage. I took some worms of the four different ages in four separate lots and fed them with mulberry leaves stained with grasserie juice; all the worms of the first two ages, without exception, died of grasserie, whereas only 40 to 50 per cent. of the worms of the third and fourth ages died of the same disease, and the rest made good and healthy cocoons. On repeating the experiment I got the same result; hence we may safely come to the conclusion that the younger ones are more prone to be attacked with this disease than the mature ones; the younger worms cannot stand the infection, but in their mature age, when they become stout and strong, they can withstand the contagion to some extent. My next experiment was to show whether the mortality is greater in injected worms or in the worms fed with leaves stained with grasserie juice. Taking some worms of the fourth and fifth ages in four separate lots, I injected the first two lots with grasserie juice by an inoculation needle, and fed the other two lots with mulberry leaves stained with the same juice; 80 to 90 per cent. of the former and 35 to 45 per cent. of the latter died of grasserie. In another experiment I took 55 and 53 worms of the fifth age in two lots and injected them with the juice; all of them died

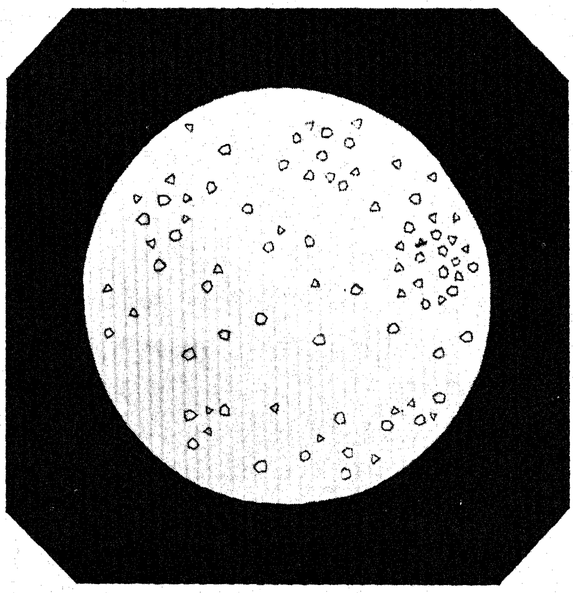
within four or five days. The result of these experiments shows that the injected worms die more than those fed with leaves stained with the juice. My next experiment was to test the acuteness of the fresh and preserved juices. I preserved grasserie juice in test tubes for eight or nine months and fed some worms with leaves stained with it; within five or six days 20 to 25 per cent. of the worms died and the rest produced healthy cocoons. At the same time I fed some more silk-worms of the same breed with leaves stained with fresh juice; within four or five days 50 to 60 per cent. of the worms died and the rest produced healthy cocoons. I therefore conclude that the fresh juice, as a source of infection, is more acute than juice which has been kept for some time. I next experimented with the polyhedral bodies seen in the grasserie under a microscope of high magnification: I crushed many worms injected with grasserie with



(*b*) Pebrine Corpuscle.
(*a*) Polyhedral Bodies of Grasserie in Bombyx.

pestle and mortar, separated the juice from the carcases, poured it into a test tube and washed it 20 to 25 times with fresh water. When the polyhedral bodies settled down at the bottom of the test tube I separated them from the juice and preserved

them in fresh water for nine months, the water being changed once a week. After nine months they appeared like a white powdery sediment. Under the microscope a drop of it showed innumerable polyhedral bodies. The under-surface of some mulberry leaves was stained with these polyhedral bodies (by means of cotton soaked in them) and some worms were fed with them ; within five or six days 30 to 35 per cent. of the worms died of grasserie. The *Antherea Perugi guer-men* of China and *Antherea Yamamai Guer-men* of Japan, which feed upon the leaves of *Quercus Serrata Thumb*, when attacked with grasserie, show some triangular bodies, and not polyhedral ones, which vary in size according to the size of the silk-worms. But the *Attacus ricini* of Assam, when attacked with grasserie, show polyhedral bodies,



TRIANGULAR AND RECTANGULAR BODIES OF GRASSERIE IN ANTHEREA YAMAMAI AND ANTHEREA PERUGI.

bigger in size than those of silk-worms. According to some, these polyhedral bodies are crystals. It is, however, more probable that they are crystalloids which can be dyed when dipped in such re-agents as Gentian violet, Safranin, Borax carmine, etc., for 12 to 16 hours. Crystals cannot be so dyed. Besides, when these bodies are crushed, 6, 7, or 8 irregular

angles are visible in them, unlike those of crystals. They are formed in the fatty tissues in the hypodermal layer, and in the tracheal membrane of the silk-worms, and in their undeveloped stage they remain in a cyst or bag in the body of the worms where they grow by division in large numbers.

As to the true cause of this disease opinion differs: some are of opinion that the polyhedral bodies are the true cause of grasserie; while others hold that when worms are infected with this disease, innumerable minute organisms (*Chlamydozoon Bombycis* of Professor Flowachek of Germany) are visible adhering to the polyhedral bodies, and that these are the true causes of the disease. Whenever I took a little membrane from the tracheal region just opposite the spiracles and stained them with different re-agents, I found these organisms; and when I separated them from polyhedral bodies, brought them up on nourishing media and fed the worms with leaves stained with the media, I found the worms infected with grasserie. I, therefore, conclude that this micro-organism is the true cause of the disease and that the polyhedral bodies are only a by-product.

I have stated already that when I fed the worms with the polyhedral bodies only (not the juice), they were also infected with grasserie. This seems inconsistent with the conclusion just stated above, but in its support it may be said that some of these organisms might have been adhering to the polyhedral bodies, and in this way might have carried the infection.

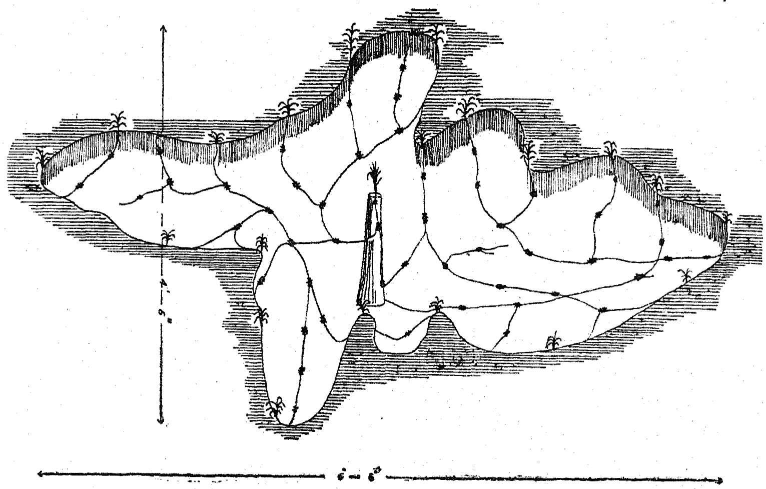
NOTES.

Note on the Life History of certain Weeds :—*Larala* (Cyperus rotundus). Studies were begun of the life history in September 1909, beds $12' \times 12'$ were planted with bulbs. These were dug up at appointed intervals and observed as below :—

A plant dug out after four months was found to have occupied a space of about one foot diameter. The maximum depth to which a plant had penetrated was 9 inches. During the period of four months it had produced five bulbs. One of these had sent up a plant and one more had sent up a shoot just reaching the surface. The distance between two bulbs varied from 10″ to 12″ and where the shoots were beginning to appear, the distance between it and the bulb previous to that was from 4″ to 5″.

After eight months the development of another plant was completely traced out as follows :—It was observed that the main plant sent out two main lateral runners underground, each of which formed a bulb in its course at every 9″ to 12″. The first bulbs of the two main runners gave out shoots above ground, which eventually developed into a plant. The plant produced in all nine bulbs of which six were on the right and the rest on the left. The second bulb on the right had produced a still deeper secondary runner having a bulb at its end. It was also observed that each successive bulb was formed deeper and deeper so that the last bulb was 18″ deep from the surface. It had occupied a space 58″ long and 1 foot wide. The deepest feeding root which was given out from the first bulb on the right side was measured to be 18″. On the surface of the runners scales were found.

At the end of the year another plant was dug up to further study the development. The following is a rough sketch of the plant.



From the above figure it will be seen that one plant has produced 53 bulbs and 20 new plants excluding the original. The distance between each bulb was from 4″ to 9″. There were two main runners—each of which has given out several secondary and tertiary runners. It was found that the deepest bulb was one foot deep from the ground level. Below this depth there was limy soil and no bulb was found penetrating this layer. The area occupied by the plant was about 20 square feet.

Harali. (Cynodon dactylon.)—A plant was dug up after eight months and was found to have three main shoots, the longest of which was 3′ 3″ with twelve branches. The distance between each node was 1″ to $1\frac{1}{2}$″ and there was a branch at every node. The whole plant occupied an area of five square feet ($2' \times 2\frac{1}{2}'$). The maximum depth to which it had penetrated was 17″.

Kunda. (Andropogon intermedius).—One plant was dug up after eight months. It was observed that it had produced underground stems which grow both deep and side-wise. The stems in several cases had branches producing palmlike branches up to ten, which branched and rebranched also individually and tended to come up to the surface. The underground runner was covered

with very closely set scales. Depth of feeding roots 14″. Area occupied by a plant one square foot which was entirely covered by the plant.—(G. K. KELKAR.)

*
* *

EXPERIMENTS WITH GROUNDNUTS IN THE BOMBAY PRESIDENCY.—On various farms of the Bombay Agricultural Department, experiments with the groundnut crop have formed an important feature of the work in recent years and some interesting and important results have been got in connection with the cultivation and the treatment of this important crop. To summarise the results obtained, it may be said that foreign varieties of groundnuts have been found to yield better than indigenous and some of them on account of their short period of growth escape the Tikka disease which affects the local variety. Spanish peanut is by far the most suitable variety to grow as a dry crop in places where rainfall is scanty and the season short. For irrigated crops, Senegal, Mozambique, Virginia and Pondicherry are suitable. Good yields are obtained by growing groundnut as a subsidiary crop to cotton and juar. Some varieties are heavier yielders than others. The heaviest yielders are not necessarily the greatest oil producers. So long, however, as the price continues to be independent of the oil percentage, the yield per acre of unhusked nuts will probably be the determining factor in deciding which variety to grow for greatest profit. Investigations carried out by Dr. Mann into the amount of oil in different varieties show that there is no constant relation between the percentage of oil in the seed and the variety, but that this percentage seems to be determined much more by the circumstances under which a particular variety is grown than by the nature of the variety itself.

The results obtained have been of much practical value to cultivators and the area under foreign groundnuts in the Bombay Presidency has shown a marked increase during the last four or five years. Last year (1910-11), the total area under groundnut in the Presidency including Native States was 159,000 acres which is 66·7 per cent. over the average of the preceding ten

years. There has also been an increase in the export trade since its fall in 1904-05. We cannot do better than refer those who are interested in groundnut cultivation to the various farm reports of the Presidency in which the results of these experiments on varieties, manuring and cultivation, are set out in detail.—(A. McKerral.)

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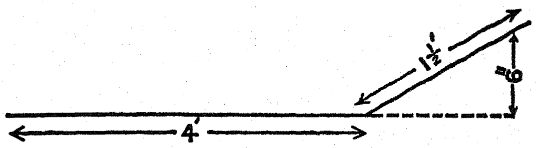
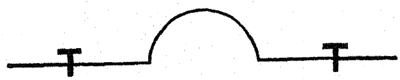
The Plough Boat.—With the introduction of heavy iron ploughs into India the necessity is sometimes felt of having some contrivance to carry the plough from place to place as it cannot be carried on the yoke of bullocks as in the case of the local ploughs. In the Report of the Agricultural College Station, Poona, Bombay, a simple device made for the purpose is described :—"It is made of a *babul* plank about 5½ feet long, 1 foot broad and 1½ inches thick. It must be so sawn from a log of wood that 1½ feet at one end should be inclined as shown in the diagram below :—



A catch made out of an iron strip and nailed down at about the centre of the plank completes the implement. The catch is made thus :—



The point of the share of the plough is inserted in this catch and the plough is hitched as usual. It can then be taken anywhere over stony and hilly ground with least draft and inconvenience. The whole thing will not cost more than Rs. 2."

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Jowar Smut.—The efficacy of steeping *jowar* seed in copper sulphate to prevent smut was strikingly shown by an experiment

performed at the same station:—"Two plots, each four *gunthas*, were sown with *jowar*, side by side, to bring to the notice of visitors the effect of steeping against *jowar* smut. One plot had its seed steeped in 1 per cent. solution of copper sulphate for 10 minutes and the other with seed which was not treated. All other *jowar* on the farm was also steeped. It formed a very interesting and instructive occular demonstration to a number of visitors assembled on the conference day and a subsequent batch of cultivators from the Poona District was very much impressed with what they saw. This was perhaps the most conclusive and striking demonstration on the farm.

The total number of plants in each plot, with the number of plants with heads attacked by smut were counted, and the figures are given below:—

TREATMENT.	Total number of heads.	Number of smutted heads.	Percentage of smutted to total.
Steeped	5,848	16	0·27
Unsteeped	5,859	1,022	17·40

(A. McKERRAL.)

* * *

THE MAIZE PLANT.—Professor F. L. Stewart, of Murrysville, Pa., has been for many years studying the possibilities of the maize plant. Ten years ago it was demonstrated that, with suitable treatment, the plant takes equal rank with the sugar-cane and the beet as a sugar-producer. Professor Stewart's theory was that, as the maize plant belongs to the same botanical family as the sugar-cane, and contains a fair amount of sucrose in its normal condition, it might be cultivated so as to increase its sucrose content up to the point where it would become profitable to work. He discovered, in the course of his experiments, that if the ears were removed at a certain period before the plant would normally cease growing, the period of growth would be increased by from four to six weeks, and during that time the anatomical structure became radically changed. The plant

increased in size and weight; the saccharine content increased to more than double its normal amount, with a purity far above that of the natural juice, while the fibre or bagasse furnished material for paper-making of a very high grade. Experiments conducted in some twenty different States during the last few years have confirmed the results obtained at Murrysville.

In a recently-issued statement Professor Stewart estimates the products of maize treated according to his process as follows :—

A ton (2,000 lbs.) of corn cane produced under the Stewart patents, contains an average of 570 lbs. perfectly dry solid matter, and of this, 270 lbs. are in solution in the juice. Of this dissolved matter an average of 240 lbs. per ton is sucrose, 20 lbs. uncrystallisable sugar, and 10 lbs. organic matter not sugar. The average yield of dry crystallised sugar is—

First sugar 96° centrifugal	160 lbs.
Second sugar 89° centrifugal	30 lbs.
Total ...	190 lbs.

About six gallons of molasses, containing about 70 lbs. of uncrystallisable sugar, remain as a by-product which is converted into ethyl spirits producing 5·18 gallons of 95 per cent. alcohol.

A ton of trimmed stalks produces, also, when milled and dried, about 300 lbs. of air-dry fibre, which gives about 200 lbs. of dry bleached paper pulp. The average weight of the leaves per acre is approximately one ton, and contains about 300 lbs. of air-dry fibre, or 200 lbs. of finished paper pulp.

In one ton of green ear and husk product there is about 580 lbs. of dry substance, of which 420 lbs. is fermentable matter, 85 lbs. of dry pulp and about 30 lbs. of corn gluten. The fermentable matter will yield half its weight (210 lbs.) for 31·1 gallons of 95 per cent. alcohol. In that portion of the corn belt where a suitable climate and soil can be secured, an average of twenty-five tons, gross weight, of several varieties of corn can ordinarily be grown per acre. Of this fifteen tons are stalks and ten tons green ears and husks.

To summarise, the yield of all products is as follows :—

SUGAR.

First sugar 96°—			
160 lbs. × 15 tons per acre	...	...	... 2,400 lbs.
Second sugar 89°—			
30 lbs. × 15 tons per acre	...	...	... 450 lbs.
		Total	... 2,850 lbs.

ALCOHOL.

From ear and husk, fermentable matter—		
210 lbs., or 31·1 galls. of 95 per cent. alcohol × 10 tons per acre....	...	... 311 galls.
From molasses produced from one ton of corn cane—		
35 lbs., or 5·18 galls. of 95 per cent. alcoho × 15 tons per acre	...	... 77 galls.
	Total	... 388 galls.

PAPER PULP.

Stalk and leaf product—		
213⅓ lbs. per ton × 15 tons per acre	...	... 3,200 lbs.
Ear and husk pulp, 85 lbs. × 10 tons per acre		... 850 lbs.
	Total	. 4,050 lbs.

(*Journal of the Royal Society of Arts, 20th January* 1911.)

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UNITED PROVINCES EXHIBITION, ALLAHABAD, " CHULA " COMPETITION.—The question of the wholesale use of cowdung or wood as fuel in India has an important agricultural bearing, so that any attempt at introducing a cheap appliance to burn coal must be of considerable interest. At the Allahabad Exhibition a "Chula" competition was held and the "Yule" prize of Rs. 1,000 offered to the inventor of the best " Chula " or stove, capable of burning raw coal. The prize was won by Mr. J. D. High, Lukergunj, Allahabad, and his "Chula" is now being manufactured and sold by the Rope Sole Shoes & Knitting Co., Limited, Allahabad. The "Chulas" are made in three sizes, *viz.*, Large, Medium and Small, selling at Rs. 14, Rs. 7 and Rs. 5, respectively.

In his note on the competition, Mr. W. R. Wilson, Director of Industries, United Provinces, remarks as follows :—

"The winning Chula is simply a cheapened adaptation of an English stove or "range :" its cost is Rs. 4-8 and it might be made stronger and more lasting, with advantage. It is very economical of fuel, for the work done. The bronze medal Chula and Mr. Apte's are on similar lines. The former has a firebrick lining to secure economy of fuel and the latter, an ingenious lining of fireclay, mud, or clay (which must be applied by hand). Both of the bodies are strong and likely to be durable. Mr. Watson's is a cheap (0-8-0) Chula and very portable (folding up like a book), it is also fairly strong. I do not think that any Chula on the stove principle can ever be free from the smoke difficulty without a chimney. The chimney carries off smoke and a clear fire is left for cooking. In a Chula after the native style the smoke will always be a difficulty. The only way to work this is to make a good "red" fire first and then start cooking. I should burn coal in the native Chula, in the above, by setting up 6 bricks, in two "courses," in the form of a , the mouth to face the wind, and putting a small iron bar grate between the first and second courses so as to be $4\frac{1}{2}$ inches above the ground."

It is reported that a considerable number of "Chulas" have already been sold among the European and domiciled communities, showing that some device of this kind was badly wanted. Apart from questions of domestic economy in the matter of saving of fuel, any arrangement which would minimise the consumption of wood, cowdung, leaves, etc., would be eagerly welcomed by those who are aware of the loss to the country that such practice entails, and it is to be hoped that the new appliance will find a ready sale.—(A. McKerral.)

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Alleged Effect on Milk of Water or Watery Food given to Cows.—It is generally supposed that it is possible to increase the quantity of milk at the expense of the quality

either by feeding cows on watery food or by causing them to drink water in large quantities immediately before being milked. Feeding of salt is also popularly supposed to make the stock consume excessive quantities of water and thus to indirectly increase the quantity of milk. To test these points the following experiments were conducted at the Midland Agricultural and Dairy College with seven typical dairy short horn cows and reported in the *Journal of the Board of Agriculture*, London, February 1911. These cattle were stall-fed during the whole of the time the experiment was in progress. Their food consisted of concentrated and dry fodders with the addition of mangolds, and at stated intervals, *viz.*, every seventh day, it was supplemented with a definite amount of salt.

The amount of water taken daily was measured by allowing each cow to drink from a graduated vessel. For the first seven days each cow had *free* access to a measured quantity of water. In the second week she was allowed to drink only just before being milked. In the third week water was free, on the fourth intermittent. Milking was regularly and expeditiously undertaken, the interval between successive milking being ten and fourteen hours, evening and morning respectively.

The cows were numbered 1 to 7, and the scheme was mapped out in days. On the first day cow No. 1 received four ounces of salt, on the second day cow No. 2 was salted, and so on. Thus one day in each week a cow received salt, and on every day of that week some one cow was receiving salt. From the experience gained in the first two weeks the experiment was altered, so that instead of giving four ounces of salt in one meal, three ounces were given after the night's milking on one day and three ounces after the morning's milking on the next day.

The result of the experiment appeared to show that periodical doses of common salt administered to cows do not necessarily cause them to consume excessive quantities of water; and that the amount of water consumed by cows has no direct bearing on the composition of their milk yield. The experiments also showed that feeding of six ounces of salt caused

purging and that even this large quantity of salt had no effect on the quantity of milk.—(EDITOR.)

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STRONG WHEATS.—The wheats most in demand by Millers in England at present are those yielding a strong flour. It is, therefore, necessary to understand what is meant exactly by the term "strength," what produces it and how it can be determined. The following is reproduced from an article on the present position of the flour question in the *Agricultural Gazette* of New South Wales, February 1911:—

The term "strength" is used by the baker to express the combination of qualities which he associates with a flour of good baking quality, such as pile, texture, shape, volume, colour, and weight of loaf. It is, in fact, another name for good baking quality. In order to place the problem on a satisfactory basis, the British Home-grown Wheat Committee has arrived at the following definition of flour-strength as "The capacity to make a big well-piled loaf." Professor Wood further points out that this is a complex of at least two factors, size and shape of loaf. The definition thus stated appears to include all the qualities the presence of which render a flour of good baking quality, and to provide a clear statement of the problem presented to us.

What exactly determines this important quality is not accurately known, and the only reliable test of the strength of a flour is its actual behaviour on baking. As this largely depends on the skill of the individual, and the methods he adopts, it cannot be considered an entirely satisfactory test, and many attempts have been made to determine the cause of strength, and to devise some means by which we might be able to determine beforehand how a given flour will behave on baking. Several factors have been suggested as being responsible for strength of flour, such as the quantity of gluten, the chemical nature of the gluten, amounts of sugar, of mineral constituents, etc., in the flour; but so far none of them have provided a satisfactory solution of the problem. The only test that has proved satisfactory in our experience is the power of the flour to absorb

water—its "water-absorbing capacity," or the amount of water taken up by the flour to make a dough of the right consistency for baking. This test, though not one that can be carried out with extreme accuracy, has, with us at all events, always proved reliable, and the power of absorbing water has always been associated with good baking quality. Without asserting that this test gives the actual strength of the flour, I do claim that it is the measure of such strength, and the best proof of its reliability lies in the fact that all Mr. Farrer's strong flour wheats were submitted to this test, and were persisted in or rejected according as they gave flour of high water-absorbing power or not.

This quality in wheat is to some extent affected by environment, by the nature of the soil and climate, and particularly by the nature of the weather during the ripening period of the grain; a hot and dry summer, in which the grain, after it is formed, is rapidly ripened, always increases the flour-strength. It is, however, an inherent characteristic of certain varieties, and soft wheats, though they may become stronger under hot and dry conditions, never attain the flour-strength of the harder strong-flour variety. Flour-strength is an inherited characteristic, and can be bred for just as colour, stiffness of straw stooling, beards, etc., can be bred for. It would appear that strength and weakness are Mendelian pairs, and the breeding of strong-flour wheats becomes, in competent hands, a certain operation, which can be regulated in the same manner as is the case with other characteristics.

Strength does not appear to be affected by manuring. Even the use of nitrogenous fertilisers, which might be expected, by increasing the protein matter, to also increase the strength, appears to have no effect on this quality.

Gluten-content.—The actual gluten-content of wheat is a matter of less importance than flour-strength. Flour-strength is almost invariably associated with fairly high gluten-content, though the reverse is by no means the case, and some of the Durum wheats, which contain up to 20 per cent. of dry gluten,

are among our weakest wheats. It may safely be said that whilst gluten-content itself is no guide to the flour-strength, still, between two wheats of the same variety, that one will be the stronger which contains the largest amount of gluten.

A high gluten-content is an almost invariable accompaniment to a dry and hot period during the ripening stage.

Colour.—As the demand for strong-flour wheat has become greater, the question of colour has assumed less importance. The wheats which produce the dazzling white flours once in demand were not those that gave high strength, but, like the Californian and the Australian wheats, were of a starchy nature, giving a weak flour.

The colour of the flour is, moreover, by no means a sure guide to the colour of the baked loaf. The very white flours often produce a loaf of a dirty grey colour, whereas those with a slight yellow tinge give almost invariably the brightest loaf.

As a rule, the strong-flour wheats give a flour which is not so high in colour (not so white), and, in order to obtain a white flour from them, patent processes have been devised for bleaching them. These processes depend, for the most part, on the action of nitrous oxide.

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MOLASSES AS A FERTILISER.—In an article in the March, 1911, number of the *International Sugar Journal*, Mr. G. N. Martin, Chemist, South African Sugar Refineries, Limited, gives an interesting account of his experience with the use of molasses as a fertiliser for canes. The account as given in the author's own words is as follows :—

"The experiments were carried out in 1897. A level piece of ground of homogeneous character was selected; the field divided into four equal plots; each plot of same length and breadth and equal quantities of cuttings planted.

"Plot No. 1 was cultivated in the ordinary way, receiving the usual fertiliser as employed on the rest of the estate—nitrogen 50 lbs., phosphoric acid 70 lbs., potash 50 lbs. per acre ; made up

of the following: sulphate of ammonia, dried blood, superphosphate and sulphate of potash.

"Plot No. II was grown with fertilisers as above, but received in addition molasses at the rate of 600 gallons per acre.

"Plot No. III received a mixture of 400 gallons of molasses, one ton (2,000 lbs.) of press cake, and 1,000 lbs. of bagasse ash per acre.

"Plot No. IV received nothing.

"The following is the tabulated result:—

	Plant canes. Tons per acre.	Ratoons. Tons per acre.
Plot No. I	34·1	28·3
Plot No. II	42·5	31·6
Plot No. III	40·2	33·8
Plot No. IV	24 6	17·2

"The molasses was employed at the rate of 400 to 600 gallons per acre, being simply spread in the furrows, and a week or fortnight after spreading, the planting was done. The quantity of molasses produced on the estate did not allow for the whole acreage to be planted to be so spread. A very marked difference could be observed between fields (some time contiguous) treated with molasses and fields cultivated with the usual fertiliser. In a good many colonies molasses is used as a fertiliser either by spreading on the ground or with irrigation water."

Similar results are also reported to have been obtained by Mr. Boname, Director of the Station Agronomique, Mauritius, from his experiments made in 1908. Mr. Boname states in his report that "the growth is vigorous, and that it is an excellent way to force a tardy plantation, and that very often it catches up and sometimes outgrows canes planted a few months previously.

"The effect of molasses is very marked, particularly with plant canes, but seems still to act on the ratoons as well . . ."
—[Editor.]

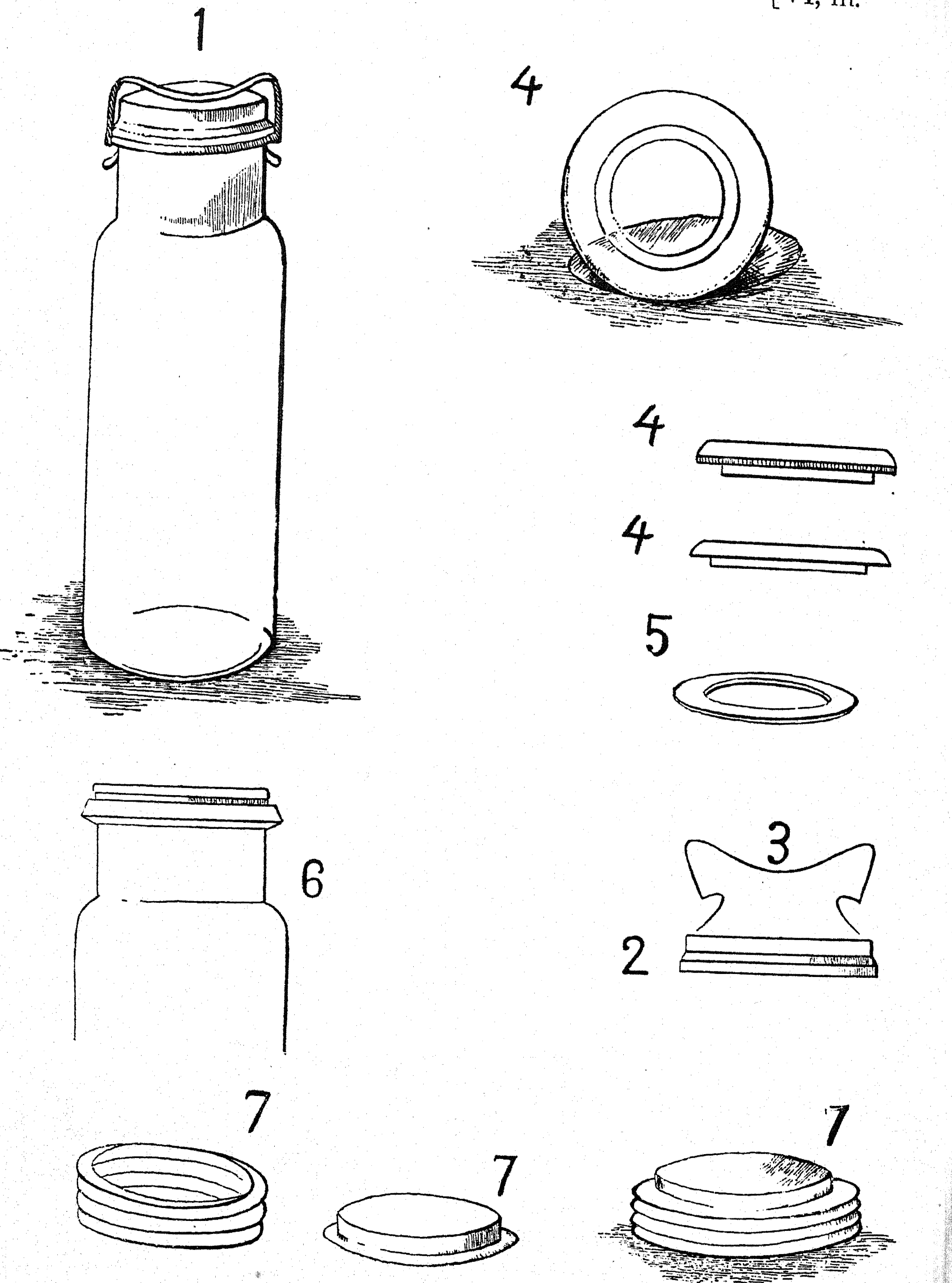
Fruit Bottling.—In an article of the March number of the *Journal of the Board of Agriculture*, Mr. J. Udale, Instructor in Horticulture, Worcester County Council, gives the following interesting account of the preservation of fruit by bottling:—

Though the method of preserving fresh fruit by the process of bottling has been practised for several generations, it is not yet so common as it deserves to be. There are two reasons for this. Firstly, the process is considered to be difficult, and secondly, there is a general impression that a special and costly apparatus for sterilisation is absolutely necessary.

With regard to the first point, it is only necessary to say that in domestic work there are few tasks more simple or easy to perform, and any ordinary intelligent person may successfully bottle fruit. As to the second point, a patent steriliser is not necessary, and the writer, who commenced bottling fruit in 1903, has never used one. All that is really required is a large saucepan, fish-kettle, or some similar vessel in which water can be heated.

Bottles.—These may be obtained specially made for the purpose, through almost any ironmonger, at from three shillings to six shillings and six pence per dozen complete, the price varying with the size and quality of the bottle. Many persons have a decided preference for bottles with glass tops, instead of metal tops, and some like the "screw" tops; whilst others prefer the bottles in which the tops, covers, or discs are held in position by "spring" clips. When counting the cost of the process of bottling, it is well to remember that the same bottles, when once obtained, may be used repeatedly until broken, the chief renewals required being rubber rings, which are used with bottles for rendering them air-tight.

It is absolutely essential that the bottles should be air-tight. An imperfectly-fitting rubber ring or cover will be sufficient to cause failure after perfect sterilisation; the rings and covers must, therefore, fit perfectly. As this cannot always be guaranteed, there will be an occasional bottle which will not be successful. This should be used at once, or the contents emptied into a new bottle and resterilised.



1.—Glass bottle with metal cap and spring fixed. 2.—Metal cap. 3.—Spr
or cap. 5.—Rubber ri

Fruit suitable for preserving.—Any fruit may be preserved by the bottling process, either whole or sliced.

Apples, pears, apricots, peaches, limes, shaddocks and lemons may all be used, though the bulk of bottled fruits consists of plums, gooseberries, cherries, raspberries, loganberries, and currants. Plums and gooseberries are probably the fruits most largely used. When once properly sterilised, and the bottles are quite air-tight, the fruit will keep for an indefinite period. The writer bottled some plums, gooseberries, raspberries, blackberries, and currants in 1903, and they are quite good at the present time.

The Use of Syrup.—Syrup is not necessary, though many persons think it is ; pure water is as suitable as syrup, and being more transparent, adds to the beauty of the fruit after sterilisation. Moreover, a thin syrup spoils the natural flavour of the fruit without making it sufficiently sweet to render further sweetening unnecessary when used. Sugar, therefore, should either not be used at all, or it should be used at the rate of half a pound (and upwards) to one quart of water. Raw sugar should not be employed, as it renders the syrup "cloudy ;" white lump sugar, however, leaves it tolerably clear.

Ripeness of the Fruit.—The degree of ripeness has a considerable effect on the appearance of the fruit after the bottling process is completed. Fruit should be slightly under-ripe for bottling, as the skin does not then so readily break during the process of sterilisation ; with ripe fruit this can hardly fail to happen and the appearance is apt to be spoiled. In this respect under-ripe fruit will bear a higher temperature without injury than the ripe fruit ; but in no case need the temperature of the water in the kettle rise higher than 200° F., and in practically all cases 190° F. is sufficient. A thermometer is required to ascertain the temperature of the water.

Quality of the Fruit.—The fruit should be sound and without speck or injury of any kind. It is best gathered dry ; but if it be damp or wet, it should be sterilised a little longer. All stalks and large calyces, as in the case of the gooseberry, should be

removed, and fruit of equal size should be placed in the same bottle. Mixed fruit, large and small sizes together in the same bottle, does not sterilise well, and has not a good appearance.

Filling the Bottles.—This is an important operation, as, if the bottles are imperfectly filled, the fruit after sterilisation will rise, and leave a large space at the bottom without fruit. Many have experienced this in their first attempts at fruit bottling. A stout stick or piece of wood, about twelve inches in length—blunt at one end and rather pointed at the other—is very useful in arranging and gently pressing fruit into position in regular layers. The fruit should be selected of nearly equal size and then arranged in the bottle systematically, the fruit being pressed into place by means of the stick when necessary. The bottle should be filled to the top of the neck, still using a little force in packing if requisite.

As the fruit is placed in the bottles, these may be filled up to within half an inch of the rim with clear water, or syrup made by dissolving half a pound of loaf sugar in one quart of water, when they will be ready for sterilising. In the case of bottles with screw caps, the latter may be placed on loosely and partly screwed down in order that they may be readily screwed down tightly directly the sterilising process is completed. In the case of bottles with caps (either glass or metal) and springs, those requiring rubber rings should have the rings softened in hot water, the cap placed on, and the spring fixed in position.

Sterilisation.—In the case of a patent steriliser the subsequent operations will vary with the kind of apparatus; but if the homely fish-kettle is used, it should be deep enough to take the bottles up to the shoulder in water. A board about one-half or three-quarters of an inch thick should be placed at the bottom of the kettle to prevent the bottles coming into direct contact with the kettle, and so causing their breakage, and a little hay should also be placed between the bottles to prevent fracture. In the absence of hay three or four folds of paper may be placed round each bottle. It is important to remember that there is

a difference in temperature between the water in the kettle and the liquid in the bottles; if the temperature of the water has been raised rapidly, there may be as great a difference as 40° or 50° F. The temperature both of the water and of the liquid in the bottles should, therefore, be raised slowly rather than rapidly to the desired maximum.

The caps, rubbers and springs, and screw-tops, having been placed in position, the bottles should be covered in cold water up to the shoulder, and the kettle placed over the fire or gas, and gradually brought to a temperature of from 165° to 190° F. The temperature necessary will vary with the kind and ripeness of the fruit; but a lower temperature than 165° F. is quite unreliable, and a higher than 190° F. or 200° F. is unnecessary.

Immediately the highest temperature has been attained, the kettle may be partly withdrawn from the fire, and the screw-caps should be screwed down as far as they will safely go. The temperature should then be maintained for fifteen or twenty minutes at about 165° F. in the case of small fruits such as gooseberries, currants, cherries and raspberries, and at any temperature between 165° F. and 190° F. for plums, apricots, peaches, and pears. In the case of the latter, forty minutes at a temperature of about 165° F. to 170° F. will answer.

Screwing down the caps.—When screw-caps are used it is most important to keep screwing them down tightly as the bottles cool and contract; the slightest access of air to the interior of the bottle may nullify the work, therefore this kind of bottle requires constant attention during the cooling process, and the tops must be constantly screwed down until contraction is completed.

Experiments.—As a result of experiments with plums sterilised in screw-top bottles in 1908, at various temperatures, it was found that sterilisation at 165° F. to 170° F. for ten minutes produced more satisfactory results than sterilisation at 190° to 200° F. respectively; and samples are as beautiful in December, 1910, as they were immediately after bottling.

FUNCTION OF SCENTS, ETC., IN PLANTS.—In the Annual Report for 1910 on the Progress of Chemistry, issued by the Chemical Society, the Agricultural Chemistry Section has again been written by Mr. A. D. Hall, F.R.S. He classes as one of the most suggestive papers of the year that published by H. E. & E. F. Armstrong on the action of chloroform and similar substances in stimulating enzyme action in living structures. The Armstrongs, using Guignard's method, show that by placing a leaf of cherry laurel in a test tube together with a drop of chloroform, hydrocyanic acid is given off in a few minutes from the cyanogenetic glucoside contained in the leaf. Vapours of ammonia, carbon disulphide, toluene, ether and various alcohols also, have the same effect and certain other substances have a similar but less effect. Guignard states that the effect of these substances is probably to induce the glucoside to travel to the enzyme by causing changes in the concentration of the cell sap. Carbon dioxide can also produce the same effect to a small extent. This slight initial excitation may be sufficient to set in motion considerable change because the hydrocyanic acid and benzaldehyde thus produced would extend the action.

Mr. Hall thinks that from these experiments light will eventually be thrown on the physiological function of many of the ethereal oils, terpenes and scents which are secreted by plants so normally that they cannot be without significance. They also throw light on the horticultural practice which has been worked out in recent years by which plants like lilacs intended for forcing are exposed to the vapour of ether for twenty-four hours or so. After this process it is found that the plants can be forced into bloom a week or ten days earlier than would otherwise have been possible. As cold acts in the same way by altering the concentration of the cell sap, we may also correlate the similar acceleration of flowering that is induced by a preliminary cold storage before forcing, and again the well-known fact that potatoes which have been frozen become sweet through an accumulation of enzyme-produced sugar.

A. E. Vinson shews that dates which have reached a certain stage of development can be made to ripen by exposure to certain vapours or solutions, practically the same substances which the Armstrongs have found to be active.—(H. E. Annett.)

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Value of Different Crops for Green Manuring.—In the *Journal of the Board of Agriculture* for March 1911, Mr. A. D. Hall has an article under the above title.

At Woburn where the soil is light and dry, it will be remembered that mustard turned under has been found a better preparation for wheat than vetches. At Rothamsted, however, where the soil is heavier and cooler than at Woburn opposite results were obtained in 1907. Further experiments carried out in 1910 at Rothamsted confirm the 1907 results.

The following table shews the yield of wheat per acre after green manuring, in Little Hoos field, Rothamsted:—

Year.	Previous green crop.	Dressed grain.	Dressed grain.	Offal grain.	Total grain.	Straw.
		Bushels.	lbs.	lbs.	lbs.	cwt.
1907 ...	After mustard	29·9	1,923	96	2,019	22·5
	,, rape	21·3	1,376	75	1,451	29·6
	,, crimson clover ...	32·5	2,096	294	2,390	36·1
	,, vetches	39·7	2,542	210	2,752	39·4
1910 ...	After mustard	19·6	1,247	34	1,281	15·3
	,, rape	20·8	1,327	37	1,364	16·3
	,, crimson clover ...	30·8	1,926	85	2,011	27·0
	,, vetches	34·4	2,144	127	2,271	34·7

Voelcker says that the Woburn results are a matter of moisture; the land being left drier after the vetches than after the mustard, as the former was much the heavier crop.

Hall says that it is not safe to assume that the amount of nitrogen and the water-supply are the only factors concerned in the above results, but the process of decay of the plant residues in the two soils may be different and one is quite ignorant of the possible influence of the intermediate products upon the growing plant.—(H. E. Annett.)

NOTE ON "WORK DONE BY THE AFRICAN ENTOMOLOGICAL RESEARCH COMMITTEE."—The African Entomological Research Committee was appointed in June 1909 by Lord Crewe, the then Secretary of State for the Colonies, to promote the study of the insects which play so prominent a part in the spread of disease among men, animals and plants in Africa. Satisfactory progress has already been made and the collections of insects received from Africa after being properly identified and recorded, are being distributed to the schools of Tropical Medicine, Universities, Museums and other Institutions where they are likely to be of value for the purpose of teaching or scientific study. Two skilled Entomologists are being employed under the direction of the Committee in East and West Africa, respectively, for the purpose of interesting and instructing the local officials in the work and also of carrying out special investigations. With a view to further the work of the Committee, Mr. Andrew Carnegie has been pleased to place at its disposal a sum of £1,000 per annum for a term of three years to defray the cost of sending a few suitably qualified young men to the United States to study the practical applications of entomology in that country. The scheme is likely to be of great value to British Administration in Africa and elsewhere by providing a body of well-trained Entomologists available for employment in the services of the different Colonial Governments. The Committee issues quarterly a Scientific Journal entitled the "Bulletin of Entomological Research" which has been noticed in Part 2, Vol. VI of the Agricultural Journal of India.

With a view to stimulate interest in, and to provide facilities for, the study of entomology, the Imperial College of Science and Technology, London, has now inaugurated courses of lectures. In a speech made at the opening of these lectures Lord Cromer, who is the President of the Committee, alluded to the existing need in England of practical field training in the methods of combating insect pests of all kinds. He referred in very appreciative terms to Mr. H. Maxwell-Lefroy, Imperial Entomologist to the Government of India, who during his leave in England has

been engaged to deliver a course of lectures on applied entomology. In his inaugural lecture Mr. Lefroy dwelt on the application of the science of entomology to agriculture, commerce, medicine and sanitation. He pointed out that applied entomology is a development of pure entomology and that this development has only recently been stimulated by the immense importance of tropical entomology. He added that the economic significance of insects rested not merely on their destructive habits but also on their yielding useful products like bees-wax, honey, shellac, silk, etc. There was thus a large field for research and useful work. He then went on to describe the losses caused to cultivators by the insect pests of cotton and cited the instances of Sind and the Punjab where the introduction of a parasite of the cotton boll-worm did an immense amount of good. Reference was made to the ravages of white-ants on railway sleepers, and weevil in wheat and rice in hot countries. Mr. Lefroy stated that in India the loss in wheat from the weevil amounts to over a million pounds sterling annually and in rice to probably three times that on the average. He laid stress on the fact that these losses are preventible and that remedial action must be founded on and guided by scientific entomology, *i.e.*, on an accurate knowledge of the lives and ways of insects causing the losses. He quoted the instances of the successful fighting of the migratory locusts of North India and the Bombay locusts; and also the checking of the potato moth by simple means within the reach of the cultivator. He alluded to the great importance of teaching farmers about their pests by means of lectures, leaflets and coloured illustrations giving them reliable information about remedies and insecticides. He then referred to the significance of insects as carriers of disease to men and to domestic animals and cited the examples of malaria, yellow fever, filariasis, bubonic plague and sleeping sickness which are all insect-borne diseases and emphasised the necessity of developing scientific and preventive entomology.—(EDITOR.)

REVIEWS.

ALKALI LAND. TWO BULLETINS dealing with the subject of the reclamation of Alkali Land have been recently issued by the BOMBAY AGRICULTURAL DEPARTMENT. The one, entitled "The Salt Lands of the Nira Valley," No. 39, by Messrs. Mann and Tamhane, has reference to some salty land in the Deccan within the area irrigated by the Nira canal. This area has been the subject of examination on several occasions: by the late Mr. E. C. Ozanne in the eighties, Dr. Leather in 1893, by a committee of agricultural and irrigation officers in 1903, and recently by the authors of the Bulletin. The immediate cause of the trouble is the canal which has caused much water-logging; but, as in all similar cases, the damage done is small compared with the advantages gained. It is, as a matter of fact, very much the worst case of damage due to a canal which is known in India; about 12 per cent. of this irrigated area has become more or less saline, and there is some evidence that the affected area is slowly increasing.

The salts present in this land include for the most part sodium sulphate and chloride, and magnesium sulphate and the land would fall under the American definition of "white alkali." As regards the origin of the salt now present in the land, the chemical examination of the river and canal waters goes to show that these are very soft and relatively pure waters, and it is concluded that the salts are largely derived from the soil.

Experiments have been made on the reclamation of some of this land at Pandhara, and these have resulted in showing that by making *open* drains 2′ 6″ deep, or such drains filled with *babul* branches, at intervals of 10ft. from one another, across the

natural drainage line, and which drains empty into major drains which run in natural lines of drainage, the land under the Nira canal, when seriously affected by salts, may be reclaimed in a very short time. The cost of drains at such short intervals is naturally high; those made by the Agricultural Department amounted to about Rs. 250 per acre, but, as the authors point out, the cost would be considerably less.

The authors make one statement which is an obvious mistake. They say "Drains running *in the direction* of the natural drainage of the land . . . are of little use . . . ." It is however certain that no system of drains which only ran across the lines of natural drainage could possibly be effective either in the Deccan or elsewhere, and as a matter of fact the system of drains actually employed in the experiments included (a) minor drains, running across the direction of natural flow, and (b) a major drain, running *in* the direction of natural flow, into which the minor drains emptied. This reclamation work must be of considerable value, and subsequent reports respecting it will be of interest.

The bulletin includes much interesting and useful information regarding the nature and quantity of the salts in the soil and in the drainage waters which cannot readily be condensed here.

The second Bulletin on the subject of alkali land, No. 35, entitled "Kalar in Sind," by G. S. Henderson, refers to experiments on the reclamation of the alkali land in Sind. In order to understand the subject, reference is necessary to the Annual Reports of the Daulatpur Reclamation Station, 1907-09. A block of 400 acres of Kalar (alkali) land has been taken up with the object of demonstrating the value of irrigation combined with a system of open drains in such land. The principle involved is of course the washing out of the salts from the soil in part down below the root-range, in part into the system of open drains. Rice followed by cotton and Egyptian clover "Berseem" have been the principal crops cultivated, and Mr. Henderson considered that as a result of 16 months' work, 200 out of the 400

acres are "sweet." The cost of the work has been Rs. 40 per acre. Incidentally Mr. Henderson expresses the opinion that the assistance of a chemist in relation to such work is not necessary. As a matter of fact, it is only after a consultation of Mr. Meggitt's analyses of the Daulatpore soil, that a correct appreciation of the nature of the sort of "Kalar" which is being reclaimed *is* possible. These analyses show that the land contains a variety of salts, chief amongst which is sodium chloride, "common salt," which is present to the extent of ·1 up to 3·0%; (in about half the samples the amount was less than ·5%) and that sodium carbonate is absent. Moreover, the nature of the salts demonstrates that the land at Daulatpore is freely permeable to water and the salts can therefore be readily washed out. This is by no means always the case in "Alkali" land; on this account drainage has often been found useless for the reclamation of such land.—(J. W. LEATHER.)

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"THE MANURING OF MARKET GARDEN CROPS." By Dyer and Shrivell (Vinton & Co. Price 1/-).—We have received a copy of this small book which has been written for the advantage of market gardeners in Great Britain, but which would probably be of interest also to gardeners in India. Sixteen years ago it was decided to start experiments on the value of artificial manures for vegetables. The universal custom had been to use only farm and stable manure, which were, and are still, used in quantities aggregating some 25 tons or more per acre per annum, the cost of which is estimated at between £10 and £20 per acre. In comparison with such quantities of manure, phosphates, chili saltpetre and potash salts have been used, and the result shows that for a majority of crops, mixtures of these artificials either alone or in combination with half the usual amount of farm manure may be used with advantage. The outturn is quite maintained and often increased. The cost of the artificials or artificials plus farm manure has been from £3 to £6 per acre.—(J. W. LEATHER.)

REPORT ON THE PRESENT POSITION OF COTTON CULTIVATION PRESENTED TO THE INTERNATIONAL CONGRESS OF TROPICAL AGRICULTURE, BRUSSELS, MAY 1910. By Prof. Wyndham R. Dunstan, M.A., LL.D., F.R.S., published by the International Association of Tropical Agriculture and Colonial Development, British Section, Imperial Institute, London, S.W. Price 1/-.—This report is a résumé of the utmost value, of the information which was supplied from many parts of the cotton-growing world. As it is the first publication of the kind furnishing us with a record of what is being done with cotton wherever it grows, it deserves a more detailed notice than is usually considered necessary in a review. The publication of the complete reports is promised later on, but the general public will probably rest contented with the present summary which provides all the information actually required. The author points out that Europe is still entirely dependent upon the U. S. A. and in a lesser degree on Egypt for its cotton supply, and any sudden shortage or falling-off in quality in this leads not only to the dislocation of the Industry but in consequence, also to many trade complications. From the United States of America, which is fortunate enough to possess the best equipped and most efficient of the agricultural departments in existence, we have an exhaustive and admirable statement of its cotton-growing industry which is the greatest in the world. There is said to be still a vast amount of land which could be rendered suitable for cotton cultivation, and it is thought that sufficient cotton could be produced in the U. S. A. to meet the increasing demand for at least another generation.

The Department of Agriculture is making efforts to obtain improved and early maturing types and also varieties resistant to certain pests. Careful experiments are in progress to determine the most suitable manures for particular soils and effect of the manurial constituents on the yield of lint and the quantity of oil in the seed. Efforts are also made to improve the farmer's knowledge of the best methods of preparing the soil, cultivation, seed selection and rotation of crops. As we find in India, the

maintenance of quality of the good types of cotton at present grown depends very largely on the efforts of the individual farmer.

In Egypt, which ranks second as a centre of production, we have also an interesting report from the Khedival Agricultural Society, under which much valuable scientific work in cotton cultivation is now being done.

The outlook is not satisfactory. There has been a serious decrease in the average yield per acre and also in the quality of the cotton produced.

During the last ten years there has been a decrease of 26 per cent. in the average yield per acre and the decrease has been continuous during the period.

The precise reason for this is not easy to ascertain. Various authorities attribute it to the ravages of the cotton worm and cotton boll-worm; others to the absence of seed selection; others again to the exhaustion of the soil following the custom of growing cotton in rotation biennially instead of triennially as was formerly the case. The problem of arresting the boll-worm has been successfully solved in the United States and should present no great difficulty in Egypt. Recorded evidence goes to prove that seed selection *is* carefully conducted. The most probable cause which has so far been suggested is that the deterioration is caused by over-watering, as so much more water has become available to the cultivators since the construction of the Assuan Dam and the barrages on the Nile. The whole matter is to be investigated by a Committee to which the scientific officers of the Agricultural Society are to be attached.

The Egyptian Government has now established an Agricultural Department. Had this step been taken before, the exact reasons for the present deterioration in the Egyptian crop would, perhaps, have been already determined.

The problem of the extension of the existing cotton area in British, French and German West Africa is very important and it is one which presents the difficulty we have in India, namely,

that the views and needs of a large population with conservative ideas must be taken into account. The only solution of the difficulty of course lies in the creation of Agricultural Departments which will demonstrate the introduction of superior varieties with the necessary methods of cultivation required by them. Much can be done also by a system of buying agencies which will ensure the cultivator getting a fair price for a superior product. The chief scientific problem to be solved in West Africa is that of establishing a type of cotton suitable to the country and the European spinner. The acclimatised types, as in India, may be greatly improved by selection and systematic hybridisation. Accounts of such work already in hand are given from various countries.

In Uganda and Nyasaland an acclimatised cotton of American Upland long-stapled type is being gradually and satisfactorily evolved as the established cotton. Favourable views are expressed as to the prospects of Sea Island cotton in several other countries: Sea Island, however, gives a smaller yield than other cottons, it is more difficult to acclimatise and requires greater care in cultivation. It is also specially sensitive to climatic changes and is particularly subject to the attacks of insects. It, however, offers splendid opportunities for successful hybridisation with inferior cottons with a view to the production of an improved acclimatised type suitable for European spinning.

In India, hasty attempts to introduce exotic cottons are doomed to failure. Experiments, which are being taken up, will assist to determine whether it will be profitable or not to introduce some of these into tracts beyond the recognised cotton-growing areas.

China stands next to India in point of production and it grows a coarse, short-stapled cotton of Indian type. It appears that the cultivation is extending and India may, in the near future, suffer from a decreased demand for the inferior cotton which she at present exports to China and Japan.

The author insists on the vital importance of the establishment and maintenance of efficient agricultural departments in

the countries in which cotton production is important. He cites evidence to prove how the application of the knowledge of Entomology, for instance, has been successful in helping the farmer to cope with the boll-weevil, the most serious of all cotton pests. Investigations also into the life-history of the boll-worm in the United States and Egypt have indicated the steps necessary to destroy this insect.

In the second part of the report the author gives summaries of reports on cotton cultivation. The writers of these reports were requested to pay special attention to the following points :—

(1) the present position and prospects of the industry ;
(2) any special difficulties met with ;
(3) nature of experimental work in progress.

In addition to the special reports which have been obtained accounts of countries from which no special reports were received have been prepared at the Imperial Institute. The whole section will repay careful perusal by those interested in the subject of cotton cultivation, as it gives the latest information compiled under these three heads from practically every cotton centre in the world.

The following are some of the deductions which can be safely drawn from a careful study of this summary :—

1. There is a general eagerness to profit by the experience gained in other countries, notably so in the U. S. A.

2. That the areas most suitable for the production of superior or standard varieties have been taken up and that other areas often of enormous extent which may ultimately prove to be equally suitable are debarred for the present by scarcity of labour, difficulty of transport, or competition with more remunerative crops or with crops more suited to the genius of the people. On the whole, the most certain methods of improvements are attained by selection of seed from the varieties already established in the particular tracts as varieties foreign to the soil are more susceptible to changes of climate and the attacks of pests.—(G. A. Gammie.)

A GLUCOSIDE FROM TEPHROSIA PURPUREA.—A Paper bearing the above title appeared in the September (1910) number of the Journal of the Chemical Society. The authors are Messrs. G. Clarke and Shrish Chandra Banerjee of the United Provinces Department of Agriculture. Tephrosia purpurea, known in the vernacular as "Jungli Nil," is common in many parts of India and especially in the United Provinces where it is often a bad weed. The work was begun in India and finished in England by Mr. Clarke at the Davy Faraday Laboratory of the Royal Institution, London. The authors show that the leaves of the plant contain about 2½ per cent. of their dry weight of a glucoside which they isolated and examined.

On hydrolysis this glucoside gave rise to two sugars which were recognised as rhamnose and dextrose respectively and also to a yellow crystalline substance. This latter was, from its properties and from analyses of its derivatives, shewn to be quercetin.

Quercetin is a substance for which there is a commercial demand as it is used to a considerable extent in the dyeing industry. The plant does not contain indican or other substance yielding indigo.—(H. E. ANNETT.)

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"CANE SUGAR" BY NOEL DEERR.—The attention given in recent years to sugar production from both the Chemical and Biological sides has resulted in a large amount of work which has modified many of our theories concerning the culture of sugar-cane and the manufacture of sugar. The literature of this subject is now extensive and it is beyond possibility for many of those engaged in sugar laboratories and factories, very often in remote corners of the world, to have access to more than a very small portion of it.

In "Cane Sugar" by Noel Deerr the reader is able to obtain an excellent general idea of the lines upon which recent work has proceeded and their practical application, as well as the methods of manufacture used in up-to-date factories. The author is well known as a Sugar Technologist and his experience in countries of

widely variant character has given him a broad view of the salient points of the industry.

Nowhere more than in India has the need been felt for a book of this kind, but it must be a matter of some regret to Indian readers that this country growing over two million acres annually comes in for such a small share of attention. It is a striking reminder of the undeveloped state of the industry, but it is hoped that material may be forthcoming to remedy this defect in future editions.

The arrangement of the book is good, but as the author has given considerable space to the botany and pathology of the cane, a chapter might very well be added, giving a more detailed account of the work that has been done on the improvement of the varieties of cane by cross-fertilization and selection, instead of dividing it into paragraphs on "Sports" and "Seedling Canes" in Chapter IV under the heading of "Varieties of Cane" and a paragraph on "Chemical Selection" in Chapter VIII under "Husbandry."

The subject is of immense importance to the industry and much time has been devoted to it by the experts in Java and the West Indies, notably in the former country where the literature in the Dutch language is not easily accessible to English readers.

In the Chapter on Sugar-cane Soils (Chapter V), the chemical analyses of typical soils of some cane districts are given and critically discussed. It is pointed out that the water-retaining power of the soil and other factors depending on the mechanical condition are of first importance, but only one incomplete example is given of the mechanical composition, although this is known to afford equal if not more valuable information than chemical analysis by the older methods.

There is abundance of material in the literature for the chapter on the "Manuring of the cane" (Chapter VI) and the author is to be congratulated on the manner in which he has placed it before his readers. This chapter which contains a detailed description of the important experiments carried out in the West Indies under the auspices of the Imperial Department

of Agriculture, will prove one of the most valuable to East Indian readers where the subject of manuring is becoming more discussed every year.

It is interesting to note that the West Indian workers, as the result of many years' experiments, have apparently succeeded in standardising, as far as the soils of those Islands are concerned, the empirical citric acid method of Dyer of determining the available plant food (page 58).

The statement on page 71 that "nitrification is essentia. to the assimilation of nitrogen by plants must now be abandoned," in the paragraph dealing with the choice of nitrogenous manures, might lead the reader to believe that it is no longer considered necessary to promote nitrification by suitable cultivation. Although it has been demonstrated that plants can assimilate ammonia under special conditions and use it to build up their protein molecule, it is still a fact that crops thrive best on soils where nitrification is active.

The paragraph on "Bacteria in relation to the Soil" in the same chapter contains no reference to the very important researches of Russell and his co-workers at Rothamsted on the bacterial flora of the soil.

India has got a great deal to learn from other countries about irrigation, and the Indian ryot is a master in the art of conserving soil moisture. The chapter on this and the husbandry of the cane, which refers exclusively to the cultivation of the varieties we call "Paunda" in this country are perhaps not of such general interest as the rest of the book to the average Indian reader who grows for the production of sugar the thin "Ukh" and "Ganna" varieties which demand quite different treatment.

These chapters, however, contain some interesting information and figures on the yield of sugar and on the methods used in different parts of the world, and we, in this country, compare with astonishment the 20,000 lbs. of sugar per acre of the Hawaiian Islands to the 2,000 to 3,000 lbs. we are accustomed to here.

The latter part of the book deals with the factory and a chapter is devoted to the discussion of each process. Chapter XI

deals with the extraction of juice by the mills, and the important question of increasing the total extraction of sugar by the various methods of saturation are worked out. There is a misprint in the formula on page 208. As it stands, it is equal to one. It should be $\frac{m_1 (f+wm)-fm}{m_1 (f+wm-fm)}$.

In this country where the cultivated canes carry a high percentage of fibre, the question of increasing the total extraction of sugar by saturation is a very important one. There is no doubt that the single dry crushing of the "Ukh" and "Ganna" canes, as almost universally practised in India, leaves considerably more recoverable sugar in the canes than is generally thought to be the case. No advantage is gained, as far as actual extraction of sugar is considered, by replacing the three roller bullock mill by the smaller type of steam-driven mills, unless saturation in some form is provided for.

The concluding chapters on evaporation, concentration and the final processes in the production of the different grades of sugar are well put together; and the chapters dealing with laboratory work contain a full description of all the modern methods of analysis.

The diction is at times a little strained, for instance the terms "haliophile" and "calciophile" might with advantage be replaced by more work-a-day expressions, but as it stands, the book will be a valuable addition to the library of the up-to-date sugar factory and plantation.—(G. CLARKE.)

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THE OFFICIAL TEXT BOOK OF EGYPTIAN AGRICULTURE is now completed by the recent issue of Vol. II. The Editors are Messrs. G. P. Foaden, Secretary, General Khedival Agricultural Society, and F. Fletcher, recently Principal, School of Agriculture, Giza, and before that Deputy Director of Agriculture, Bombay Presidency. Vol. I contains preliminary articles on Soils and Manures, etc., and three valuable contributions by R. Lang Anderson, Director of the Aboukir Reclamation Company, Alexandria.

He is head of the company which has successfully reclaimed the site of the old salt lake of Aboukir. These comprise Irrigation and Drainage, Farm implements of Irrigation and Land Reclamation. It is on a system similar to that outlined in this latter article that the Doulatpur Reclamation Farm in Sind is based.

The second and final volume consists of articles on farm crops, rotations, fruit and vegetables, farm pests and farm live-stock. The chief article in the book is that on cotton by Mr. G. P. Foaden.

In Egypt the annual production of cotton is about 1/10th that of the United States and about $\frac{1}{2}$ the average Indian crop. The yield per acre is high, but for various reasons is steadily diminishing, being about 400lbs. lint cotton per acre. This compares with an average of 200lbs. in the United States and less than 100lbs. in India. The Agricultural position of Egypt and the prosperity of the Egyptian cultivator is based on the quality of the fibre produced; the production of high grade cotton has been in the past almost an Egyptian monopoly.

Mit-Afifi or Egyptian brown, forms the great bulk of the crop and is hardier than Abassi which is the only white cotton grown in Egypt. In general the 'fellah' takes the greatest care over his cotton, the land is ploughed and ridged after berseem, sown by hand, thinned and constantly hoed till the plants meet in the row. In the south it comes every three years in the rotation, but on the coastal lands of the north it comes every second year.

Among the cereals maize is the chief hot weather crop with a smaller area of sorghum. Rice is cultivated in the salt lands of the Delta, also a 60-day variety is used to "sweeten" the ground and is often grown as a catch crop between the main cold weather and hot weather crops. Wheat, beans and barley are the cold weather grain crops. In Upper Egypt these crops are grown on the 'basins' (*i.e.*, large 'bunded' areas of land flooded on the rise of the Nile), the seed being often broadcasted in the wet 'gup' when the river goes down. 'Tibn' or chopped

wheat (and to less extent barley) straw is almost as valuable as the grain; it is the universal fodder for all animals in Egypt in the hot weather and often sells at £1 per camel load.

Sugarcane is grown in some districts of Upper Egypt and a little in Lower Egypt; it takes the place of cotton and is generally grown under the encouragement of one of the large sugar-making companies to whom the cultivators sell their canes.

There is a large area under garden and fruit and vegetables; the latter consist largely of cucurbits and onions. Fruit culture is poor except grapes and dates.

The other crops are of minor importance except berseem (Trifolium alexandrium). This is the backbone of Egyptian agriculture and it renders possible the intensive cultivation practised, where crop follows crop in endless succession. It practically forms the sole food of all live-stock from November to June. Out of 5 million acres of cultivated ground in Egypt $1\frac{1}{2}$ millions are sown down to berseem each year. It is far superior to lucerne for the cultivators' purpose for the following reasons :—

1. It is purely a cold weather rotation crop and does not take the place of any money-making crop.

2. Will give three cuttings before the first cut of lucerne could be taken.

3. It will grow on salt land if plenty of water and drainage is available.

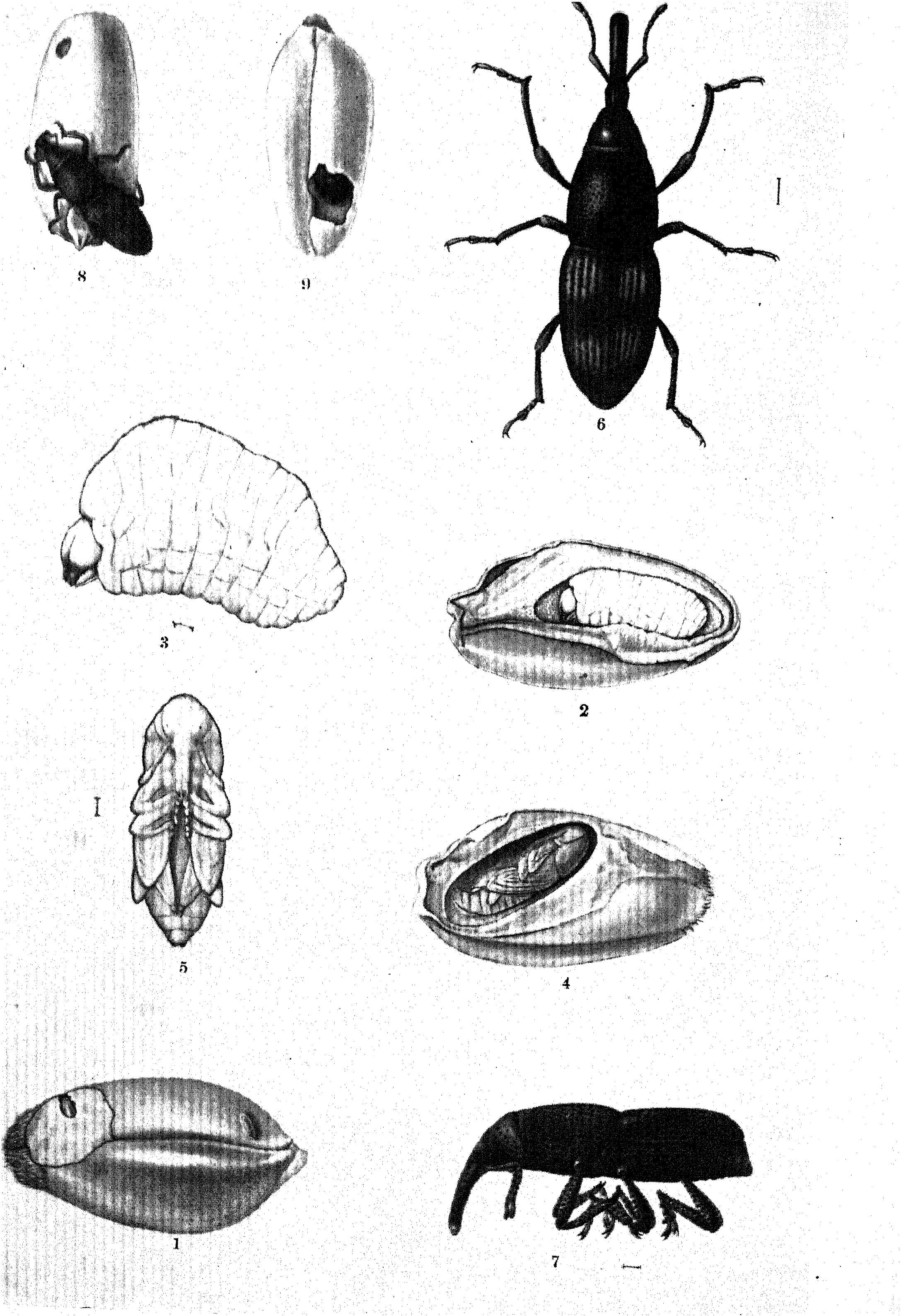
Four varieties are mentioned in the book, but the basin berseems are looked on more or less as weeds in Lower Egypt. Seed for use in India should be obtained from the salt lands of the extreme north.

A section is contributed by Mr. J. S. J. McCall on farm animals. Work cattle as compared with many Indian breeds are mixed and patchy and show no signs of any fixed breed. They are often of good size but are very expensive; £20 is common for a good bullock.

The article on insect pests is interesting. Cotton boll-worm is a terrible scourge and in an average year the loss due to it

approaches a million pounds sterling. The cotton worm which eats the foliage is also a serious pest. It is specially bad in the North where in a bad year as much as half the crop is spoiled. In 1905 cotton-growers were compelled by special legislation to pick off the leaves on which eggs had been laid and to destroy them under pain of a heavy fine. This has resulted in a very general improvement. There are a number of other pests as cotton aphis, cut worm, stainer, weevils and stem borers. Spraying and such methods are not considered feasible on a large scale to combat these pests.

The book on the whole is of great interest to India, especially to the canal-irrigated tracts. Owing to the method of its preparation there is some overlapping and the Editors state that the book is presented as a series of detached contributions for which the writers are personally responsible.—(G. HENDERSON.)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EXPLANATION OF PLATE.

THE RICE WEEVIL (CALANDRA ORYZŒ).

Fig. 1. Eggs laid on and in a Wheat-grain. x 8.
,, 2. Larva feeding inside a grain. x 8.
,, 3. Larva removed from grain. x 16.
,, 4. Pupa in natural position inside grain. x 8.
,, 5. Pupa removed from grain, ventral view. x 16.
,, 6. Adult Weevil from above. x 16.
,, 7. ,, ,, ,, side. x 16.
,, 8. Weevil gnawing into a Wheat-grain x. 8.
,, 9. Weevil inside a Wheat-grain. x 8.

WEEVIL AND DRY WHEAT.

By T. BAINBRIGGE FLETCHER, R.N., F.E.S., F.Z.S.,

Offg. Imperial Entomologist.

Introductory.

An insect that does an immense amount of harm in India is the common Rice Weevil (*Calandra oryzæ*), found not only in wheat but in *juar*, maize, rice and, indeed, in all stored cereals and peas, though best known in rice. Owing to its minute size it is easily overlooked until its numbers have increased to an extent which makes the aggregate loss very large, small though the individual damage may be. Its small size may best be realised from a consideration of the fact that its life-history is accomplished inside a single grain, which furnishes it at the same time with food and shelter. As in the case of most destructive insects, however—locusts may be taken as an exception—the amount of damage done is inversely proportional to the size of the insect.

Not only does the Rice Weevil attack cereals in the grain, but it will also feed on them when ground, and (in India at least) this little beetle is one of the principal offenders in the case of a bag of flour being found "weevilly" when opened. It is only fair to add, however, that this weevil is not responsible for the repulsive taste communicated to the flour by other minute beetles (*Tribolium*) often found in the flour also. Rice and wheat in the ear are not, or only very slightly, attacked, but barley in the ear is as much subject to attack as when husked.

In many parts of India endeavours are made to secure grain against insect and other attack by storage in tight receptacles, although these need to be practically air-tight to keep out minute insects such as this; but in some districts, although

the grain is stored in a sort of wattle cage to keep out rats—sometime a cat is shut into the cage with the grain to make assurance doubly sure—yet no attention is paid to destructive insects which breed unchecked and devour the cultivators' store none the less surely than the rats. *De minimis non curat agricola* might well be given as the modern version of an old saw.

It is extremely difficult to estimate the actual damage to stored crops done by this weevil. Such must vary to a very large extent according to local conditions. The following experiment, however, carried out in the Pusa Insectary, will give some idea of the harm which may be done. On 27th April 1910 one seer (2lbs.) of unaffected wheat grains was put into a box with a large number of wheat weevils and left; on 1st October 1910 (*i.e.*, after 167 days) the weevils and dust were separated from the wheat-grains, the dust weighing $\frac{1}{2}$ chittak (1 ounce), the wheat-grains only 11 chittaks (1lb. 6oz.) so that roughly one-third of the wheat had been totally destroyed in less than six months. Some twenty years ago a leading firm of grain merchants estimated the annual loss due to these weevils to be 10% in the year. Taking the annual average loss at only half this (5%), the damage done yearly throughout the whole of India must run into lakhs of rupees.

Distribution.

Like nearly all grain pests, the Rice Weevil has been carried all over the world with shipping, and it is very difficult to say where its original home may have been, but we have no reason for believing that it is not indigenous in India. This weevil does not seem to have been known to Linnaeus in 1758, the date of the Tenth Edition of the "Systema Naturæ," but was described five years later in the sixth volume of his "Amœnitates Academicæ." The Twelfth Edition is not accessible here, but the species is included in the Thirteenth (Gmelin's) Edition (1788-1793) without any further indication of origin than the words, "Habitat in oryza, diutius asservata." We may assume that the species had attained a world-wide distribution before it

was known to Entomologists, and that its original home was probably in the warmer rice-growing districts of Southern and Eastern Asia. It is abundant everywhere in India, Burma and Ceylon, and is known under various vernacular names, some of which are "Chele poka" (Bengal), "Hena poka" (Nuddea), "Sulsi" (Delhi Bazar, Calcutta), "Ghun" and "Keed" (United Provinces), "Sonda-Kida", "Sonda" and "Pore-kida" (Poona), "Keri" (E. Bengal), "Kapra" (Delhi), "Kurrin chottan" (S. Malabar), "Nusi" (Ceded Districts), "Sundawalla poka" (Orissa), and "Sundhiu Killu" (Gujerat).

Life-History.

In colder climates it is said that this beetle has only one* generation in the year, but in the warmer parts of India it is probable that there are about eight broods annually, whilst in districts with an appreciable amount of cold weather there may be only four or five generations in the year.

The length of time occupied in attaining the perfect state during the warmer months varies from about five to nine or more weeks, as is seen in the following table of actual records kept at Pusa during 1910:—

Parents put into a jar of Wheat.	Young emerged.	Period in days.
10–12 March.	27–30 April.	49–50.
27–30 April.	15 June.	47–50.
28 ,,	20 ,,	54.
20–22 June.	25 July.	34–36.
8 July.	12 August.	36.
8 ,,	15 ,,	39.
20 ,,	26 ,,	38.
22 ,,	26 ,,	36.

It would naturally be expected that in the hottest month of the year (*i.e.*, May) the life-history would occupy the shortest period, but it is evident from the above table that such is not the case and another factor must be sought for. By plotting the results of the table in the form of a curve and adding

* The statement is attributed to Miss Ormerod, but I have been unable to trace the original reference.

curves for the average mean temperatures for this period of the year, it immediately becomes apparent that the curves do not coincide; but the addition of another curve, that of atmospheric humidity, helps to throw a little light on the subject, and there seems little doubt, but that—at any temperature at which breeding is possible—the period of development of the immature stages varies inversely with the degree of humidity of the air. The practical application of this point will be discussed later on.

Returning now to the life-history of the weevil itself, in its first stage it is a minute egg about ·6 m.m. long and ·25 m.m. broad, cylindrical in shape with perfectly rounded ends and a smooth surface, and of a clear translucent colour. (Frontispiece, fig. 1). The mother-weevil gnaws a small hole almost longitudinally into a wheat-grain, usually near the apex which is provided with a covering of minute hairs. The egg is thrust into this hole lengthwise, and sometimes the mouth of the hole is then plastered over with chewed-up dust from the wheat, but sometimes the hole is left open and then the end of the egg is visible almost on a level with the surface of the grain. On splitting open the grain it is extremely difficult to distinguish the egg from the interior, its colour being so similar to that of the starchy substance of the grain itself. In many cases, however, the eggs are simply deposited loosely amongst the grains or stuck to the outer surface of a grain in an exposed position, without any hole having been bored.

The eggs hatch as a rule on the fourth day after they have been laid, when the young larva gnaws a hole in the side of the egg-shell and makes its way out with a sort of peristaltic movement. Except for its smaller size, about ·6 m.m. in length, the young larva resembles the full-grown one in every respect and, like it, assumes a curved position with the back arched upwards. (Figs. 2 and 3). On hatching out, the young larva bores into the interior of the grain in or on which the egg was originally laid and consumes the starchy substance of the interior, passing its whole larval and pupal life inside this one grain. When fully grown the larva is about 2·5 m.m. (1/10th inch) in length

when fully stretched out, but it usually remains in a slightly curved position (fig. 3) with the back humped up, and in this state it barely measures 2 m.m. long. It is a thick, fleshy, white, legless grub and, except for its brown or yellow brown head, it has no markings of any sort, but the body is minutely wrinkled transversely. As it never leaves its food supply, it has no need of legs but it can move about by peristaltic motions of its muscles; for the same reason, no outward sign of damage is shown by the grain whilst the larva is inside it.

The pupa is about 2·5 m.m. (1/10th inch) long, of a very pale yellow colour, after about three days turning to a darker brown. The posterior extremity is bent downwards a little and, as is the case in all ordinary curculionid pupæ, the legs and snout are clearly distinguishable (figs. 4 and 5). The larva pupates inside the grain, in which it has been feeding, in a small chamber cleared by pushing to one side the pellets of frass and flour. No hole is prepared for the emergence of the beetle, which gnaws its own way out. The holes found in affected wheat are thus caused by the weevils which have attained the perfect state, either on their first emergence from the pupa or by their subsequent gnawing of the grains in the process of feeding. The pupal period is about six days in the warm weather.

The weevil itself may live a few weeks or several months, and in the northern parts of India generally passes through the cold weather in a dormant condition. It is a very small dark-brown beetle, about 1/10th inch long, with four orange-coloured spots on top of its body and the usual long down-curved beak characteristic of the weevils. (Figs. 6 and 7).

In the case of most insects the damage which they cause is effected during their larval existence, but the Rice Weevil on the contrary is destructive after it has reached the perfect state by gnawing into grains and feeding on their contents (figs. 8 and 9), and it seems probable that the destruction wrought by the beetle after attaining maturity is greater than that done before it has attained this condition. As the food-supply is constant, there appears to be no regular breeding-season and all

stages of the life-history may be found at any period of the year, although when the temperature is low all vital activities are decreased up to the point of suspension. The mature beetles themselves may also apparently live for a long time, so that members of more than one generation may perhaps be found occurring together. Owing to these two points, it is extremely difficult to say how many generations there may be in a year in any particular locality, but the average is probably about eight for Southern India and about five for the colder regions of the North.

MEANS OF CONTROL.

Had the Rice Weevil no natural enemies, there would be no limit to its increase but the want of food or, in other words, its consumption of our stored cereals would be absolute. Living a life of concealment, as is its habit during its early stages, it would be imagined that at this period of its existence at least it would prove comparatively immune from enemies: happily for man's welfare, however, this is not the case, as during its larval life it is extensively parasitised by a minute coppery-green Hymenopterous (four-winged) fly which has been called *Pteromalus oryzæ* after its host. This tiny fly searches for a grain containing a larva of the weevil and lays an egg in the larva; this egg hatches into a grub which feeds inside the weevil larva without actually killing it till it is itself full-grown, when it attacks the vital portions of its host, kills it, and then changes into a pupa, from which there presently emerges another tiny coppery-green fly ready to pair and (should it be a female) to search for more weevil-larvæ in which to lay its eggs.

Useful though this parasite undoubtedly is, it is obvious that its usefulness must be of limited application, as a parasite which is too successful will soon have its numbers reduced by want of a host on which to feed. We must therefore consider artificial means of control and these fall under two heads, (*a*) *fumigation* and (*b*) *drying the grain.* In considering both of these it must be understood that wheat in grain is especially referred to.

FUMIGATION.

Fumigation is quite a simple matter if the grain is contained in a receptacle which is, or can be rendered temporarily, more or less air-tight. Carbon Bisulphide, at the rate of about $1\frac{1}{2}$ lbs. to the ton of grain, is the usual fumigant, the liquid being simply poured over the grain or placed in shallow vessels on top of it, and the grain exposed to the fumes for 24 hours. It must be remembered that the fumes of Carbon Bisulphide are an irritant poison if inhaled to any extent, although the smell is calculated to prevent this being done. It is still more important to note that this liquid is inflammable, and that the fumes form an explosive mixture when mixed with air in the presence of fire and that no light or fire (even a lighted pipe or cheroot) must be allowed near when fumigation is going on.*

Fumigation will simply kill all insect life in the grain but will not exert any permanent inhibitory effect, so that the operation should be renewed at least every six weeks. A more permanent deterrent effect is produced by mixing a small proportion of naphthalin with the grain. This is especially useful for keeping small quantities, such as samples for Exhibition purposes. If required for culinary use, the larger lumps of naphthalin may be sieved out and small fragments evaporated out quickly by exposing the grain in a thin layer to the sun and air for a day or two. The germination of the wheat is not affected. In one experiment conducted at Pusa, a boxful of wheat was taken, covered loosely with a sheet of paper on which a layer of flake naphthalin was sprinkled, and left under these conditions between 27th April and 1st October. On this latter date the wheat was found absolutely free from weevil, and two samples tested for germination by actual growing gave results of 82% and 68% respectively. Another box of wheat kept under exactly similar conditions but without the naphthalin, was found to be badly attacked by weevil at the expiration of the same period.

* For further details see Indian Insect Pests, pp. 258-259.

Dry Wheat.

Experiments carried out at Pusa during 1909 appear to indicate that wheat will not be attacked by weevils under certain conditions of dryness. In co-operation with the Imperial Agricultural Chemist various samples of wheat were taken and prepared at different degrees of dryness, and these samples were then tested with living weevils to see how far the weevil was able to live and breed in each.

The experiments, which were all done in triplicate to avoid error as much as possible, were made with similar bottles each containing one pound of wheat dried to a known degree of moisture and forty living adult weevils. The bottles were then closely stoppered, sealed with paraffin wax, so that they were absolutely air-tight, and left undisturbed for six weeks. At the end of this period they were opened, the original forty weevils in each bottle searched for and found, any further weevils noted, and the whole kept under such conditions that any immature individuals would be afforded time to hatch out or that any apparently dead weevils would have an opportunity of reviving.

Two samples of wheat freshly harvested and taken straight from the threshing floor in 1909, were found to contain 6·7 and 7·2 per cent. of moisture respectively. It would appear, however, that these ratios were abnormally low as the following percentages of moisture were found in wheat harvested at Pusa in 1910, care being taken that the samples suffered as little loss as possible from the harvesting until they were secured in bottles :—

Mozuffernaggar White	...	...	10·16	Per cent.	Average 8·62.
Punjab, No. 2	...	...	8·27	"	
" " 4	...	...	8·12	"	
" " 7	...	...	7·99	"	
" " 9	...	...	8·14	"	
" " 12	...	...	7·75	"	
" " 14	...	...	8·09	"	
" " 16	...	...	9·10	"	
" " 17	...	...	8·63	"	
" " 19	...	...	9·39	"	
" " 20	...	...	9·24	"	
" " 22	...	...	8·55	"	
" " 24	...	...	8·69	"	

By ordinary drying of this wheat in the sun after harvesting it was found that the moisture-content could be reduced with ease to about 4 per cent., whilst the same wheat exposed to the open air until July (after the rains had set in) then contained 14·1 per cent., of moisture. By drying or damping this, exact degrees of moisture were of course obtainable.

(*a*) In the experiments made with absolutely dry wheat (0 per cent. moisture) and with wheats at 4·1 per cent , 6·7 per cent. and 7·2 per cent., all the weevils introduced were killed off without breeding at all.

(*b*) In the experiments with wheat containing 8 per cent. moisture, the weevils became inactive after a few days and were apparently killed off without breeding.

(*c*) In the 9 per cent. wheat active breeding did not go on at all ; the bottle was opened after six weeks, examined and closed again ; after this exposure to fresh air of greater humidity, the weevils became more active and breeding commenced.

(*d*) In the 10 per cent. samples there was rather more activity and a little breeding took place. When opened after six weeks and exposed to a damp air breeding became very active and the immature stages were passed through more rapidly than when kept at 10 per cent. A moisture-content of this value would appear to allow breeding though if the air is unchanged in the confined space of a bottle, this is slow, and it is accelerated when air is allowed free access.

(*e*) The 12 per cent. wheat was a failure from an experimental point of view, no weevils living or breeding at all. On opening the bottle some smell was perceptible, and it may be that some chemical action had occurred. Otherwise, there seems to be no satisfactory reason why the weevils should not have flourished.

(*f*) In the 14 and 16 per cent. samples, there was breeding in some bottles but not in all. It must be remembered that 14 per cent. is the moisture-content of wheat exposed to the open air at the beginning of the rains, when the conditions are at their optimum from the weevils' point of view.

(*g*) Experiments made with wheat damped to contain 20 and 25 per cent. of moisture were a total failure, the wheat mildewing in all the bottles and the weevils being rapidly killed off.

In estimating the value of the above experiments, it must be remembered that they were made under unnatural conditions distinctly adverse to the well-being of the weevils, which were tightly sealed up in a confined space and cut off from any change of air. Then, again, the weevil is not an easy creature to work with, since its immature stages are passed in concealment, so that it is not easy to see what is going on. Too much reliance, therefore, must not be placed on these experiments, as the confined conditions on a small scale such as this may not give an exact reproduction of what would take place on a larger scale under exposure to the open air. But the above results (experiments (*a*) and (*b*)) apparently justify us in saying that wheat which can be got down to a moisture-content of 7 per cent. or less in April-May before being stored should be immune from attacks of weevil and, if it can be stored in insect-proof receptacles, it should remain free from attack, even after the rise of humidity has brought its moisture-content above the critical point. We have seen that wheat can be dried in the sun to about 4 per cent., and this should provide an ample margin, of safety. As the experiments were made with Behar wheats presumably an even lower moisture-content would be obtainable with Punjab wheats, as these latter would be drier on coming from the threshing-floor.

Although bottle experiments on a small scale serve little purpose in indicating what may be expected on a large scale, as we have to take into account so many factors, the chief of which is the fact that the weevil is a living animal with its individual likes and dislikes and vitality ; yet they serve to indicate roughly the limit of safety, which may itself vary slightly in different varieties of wheat.

To summarise the foregoing :—

(i) Wheat when threshed contains about 8 per cent. of moisture.

(ii) By exposure to the sun in April-May, this may be reduced to about 4 per cent.

(iii) Whilst containing less than 8 per cent., stored wheat is immune from attack by weevil, and any weevils which may obtain access to it are soon killed off.

(iv) If stored in insect-proof receptacles wheat which is already free from weevil will be preserved from attack.

RURAL ECONOMY IN THE BOMBAY-DECCAN—IV.

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(*Continued from page 220 of Vol. VI, Part III.*)

VII.—Dead Stock.

The implements commonly used by the Deccan cultivator are as follows :—

1. The *Nangar* or plough, of various sizes, cost Rs. 2 to Rs. 10.
2. The *Púbhar* or seed drill, cost Rs. 5.
3. The *Kulav* or harrow, cost Rs. 3-8.
4. The *Kolpa* or bullock hoe, cost Rs. 2.
5. The *Maing* or clod crusher, cost Rs. 4.
6. The cart, cost Rs. 40.

Hand Implements.—

1. The *Kodali*, used as a hoe, pick or spade, 6 annas.
2. The *Khurpe*, a small sickle used for weeding, etc., 2 or 3 annas.
3. The *vila*, or sickle, 6 to 8 annas.

In cases where there is an irrigation well the *mhot* or leather water bag will be required. With pulleys, ropes, etc., its cost may be taken at Rs. 40.

Implements of the kind mentioned above have been in use in the Deccan from time immemorial. They are ingenious, and up to a certain point effective. They are made mainly of wood,

and contain as little iron as possible. They have the merit of being cheap and easily repaired; but they cannot be said to be efficient according to the modern standard.

In India, as elsewhere, the plough is about the most important agricultural implement. As regards ploughing the custom varies greatly in different parts of the Deccan; but in some parts it is customary to plough deep every year; and in all parts the land must be well ploughed for irrigated crops. In the case of black soil which is infested with deep-rooted weeds the only method of cleaning the land is to plough deep; and the heavy black soil of the Deccan presents many difficulties to the cultivator. It is therefore most important that the large plough should be an efficient implement. But anyone who takes the trouble to observe a heavy plough at work must admit that it is a clumsy implement, and that it gives a small result for a large amount of labour applied. Five or six yoke of oxen, with several drivers besides the ploughman, may be seen straining at the task, and making very slow progress. It would be out of place here to enter into the merits or defects of various implements; but it may be said generally that a change is bound to come over Indian implements in the near future and is already beginning. This change will be accomplished here as it has been in other countries by the introduction of a new factor in the case, namely, cheap iron. The change in England dates from the beginning of the 18th century when the improved process of iron and steel production revolutionised agricultural implements, and proved the greatest boon to English agriculture. The change took place later in other countries; and in parts of France the wooden plough, practically the same as the old Roman plough, might have been seen at work as recently as 30 years ago. France is now well to the front in the matter of agricultural machinery, and is very well provided with workshops where implements are made and repaired. In every European country implements of all kinds have been designed to suit the requirements of various soils and various crops; and the process of specialisation and evolution is being pushed on with skill and perseverance. It is

cheap iron which has made this possible. In the Deccan there is little movement so far; but something is being done. Pickaxes which were introduced by the Engineering Departments are now becoming quite popular, and hundreds of iron turn-wrest ploughs are purchased annually. A machine which has advanced many stages during the last century is the sugar-cane mill. The old stone mills containing a hole in which the cane was pounded may still be seen lying about in the fields. They were replaced about 100 years ago by a two-roller wooden mill, which was a great advance. These in turn have been supplanted in most parts during the past 15 years by the three-roller iron mill; while during the last few years several power-driven crushers with six or more rollers have been erected; and more are likely to be erected in the near future. So long as it is necessary to import iron implements from other countries, it is impossible that the detailed attention necessary to adapt them to local requirements will be forthcoming; but already in the Deccan several iron foundries have been started for the manufacture of agricultural implements. Iron will very shortly be produced in India; and the day is not far distant when India will be in a position to make agricultural implements designed for its own special purposes; and to provide effective workshops for their repair. When that day arrives, the cultivators will not be slow to recognise where their advantage lies.

The chief advantage of efficient implements is, of course, that they save time and cheapen production. It does not end there, however; for there is many a man who would be ready to take up agriculture if he could work with efficient machines; but who prefers to stand out of it altogether rather than to use the primitive methods in common use. This is a matter of some importance in the present day when the educated classes are beginning to think of farming as a profession; and doubtless accounts for the interest that such men often display in the question of advanced agricultural machinery. Meantime it must be recognised that in the matter of dead stock the Deccan farmer is very badly equipped. Looking at stock as a whole, live and dead, we may

take a substantial cultivator with 40 acres of unirrigated land and allow him the following :—

		Rs.
Two pairs of bullocks at Rs. 75 each bullock	... ...	300
Four cows at Rs. 30 each	... ...	120
Implements	... ...	80
Ready cash	... ...	100
	Total ...	600

His capital figures out at Rs. 15 (£1) per acre; whereas the tenant farmer in England is expected to have for the same purposes £10 (Rs. 150) per acre.

VIII.—Circulating Capital.

Under this heading may be considered the grain, fodder and manure which are kept in hand.

Grain.—Under ordinary conditions in India the striking thing is how very little produce the farmer has in hand after harvest is over. His general shortness of capital causes him in most cases to cut down this form of capital ; in other words to convert into money, as soon as possible, any produce that he can collect from his fields. He can seldom afford to stack his harvest, and thresh, winnow and market it at his convenience. If he were able to do so, he might get on with his ploughing in the cold weather, before the ground is too dry and hard, and dispose of his produce in the hot weather when field operations are brought to a standstill. But he generally cannot afford to stand out of his money for so long, and he puts his produce on the market at a time when everyone else is doing the same, and prices are at their lowest. In many cases he obtains an advance against the crop, and in such a case his only concern, at harvest time, is to adjust the balance with the sowkar (money-lender) in whose hands he has placed himself. If the cultivator could afford to hold up his produce longer he could doubtless obtain better prices and suit his convenience better. The question of holding up produce for a good market, must not be confused with the question of keeping a permanent reserve of grain. It is

common to hear old people deplore that, now a days, cultivators do not maintain a permanent reserve of grain as they used to do. Formerly, in out-of-the-way tracts, grain was stored to a great extent in the villages; but now, few people keep more than enough to last them till the next harvest. It is, however, doubtful whether this change is a matter for regret. Grain was formerly permanently stored by cultivators, because there was no ready market for it. Now a days they can always find a market for selling and for buying grain, and they keep no permanent reserve. It is argued that the money so obtained is spent at once, and that the man is worse off for not having his reserve of grain. It is certainly a fact that the standard of comfort has risen; but the standard is not so high that we need deplore this. Under modern conditions there is no difficulty in marketing produce, no fear of the grain becoming exhausted in any locality, and far less fear of lack of employment. The poorer classes have adapted themselves to the new conditions.

Fodder.—The extreme shortness of fodder has already been remarked upon. In many tracts hardly any store is carried over from one year to another, and little even to the hot weather. A striking fact noticed in the recent famines was that some of the tracts where fodder was usually most abundant, such as Khandesh, suffered most severely, and lost more cattle than the localities which ordinarily produce far less fodder. In many localities fodder is so scarce even in an ordinary year that it is very difficult for the people to store it against a famine; but in other tracts where it is usually plentiful, its value is overlooked, and it is largely wasted. Unlike grain, fodder cannot be readily imported from a distance to supply any local deficiency. Its bulk prevents this; and when transported to a distance the cost of carriage makes its price prohibitive. There is probably a good opening in the Deccan for compressed fodder which is easily portable and can be kept for a long time. Kadbi (jowari stalk), the common fodder of the country, may often be found selling at one place at 500lbs. to the rupee, and at another place not far distant at 50 lbs. to the rupee. This, however, is a matter for experiment and enterprise.

The ordinary cultivator must maintain his own fodder reserve if he would avoid disaster.

Manure.—The cultivator of dry crops in the dry tract sets little value on manure. He stores carelessly what farmyard manure comes readily to hand; but would never buy it. In tracts of better rainfall the farmer values it more; but it cannot be said to be an important item of his capital. With the garden cultivator it is otherwise. He stores it carefully and buys it largely. Sugar-cane is manured at the rate of 60 cart-loads per acre. A cart-load works out at about one-third of a ton and costs about 14 annas. Where garden cultivation has increased complaints are often heard of the high price of farmyard manure; but it is still the cheapest form of manure, and its nitrogen works out at Rs. 2-10 per unit, as against Rs. 8-8 per unit of nitrogen in sulphate of ammonia, Rs. 9-4 in safflower cake, and Rs. 12-2 in castor cake on the "ton per cent." basis. Castor cake is used in some tracts as a top dressing for sugar-cane, and is a considerable item in the cane grower's bill. To the bulk of cultivators, however, manure is not a formidable item of expenditure, nor a matter of much care. Artificial manures are almost unknown.

IX.—Reserve Capital.

Provision for unforeseen expenditure, sinking fund and insurance.

There is not much to say about these forms of capital except to point out their necessity. In every business accidents may happen, and adverse periods will occur. In agriculture this is particularly the case. In the Eastern Deccan owing to the vagaries of the rainfall, a year of scarcity may be looked for once in five years, and a serious famine every ten or twenty years. Many theories are advanced as to the reasons why failure of rain should cause such acute distress. Without attempting to investigate the reasons why the cultivator has not got more capital at his disposal, it may be stated that he has little or no reserve capital; and this circumstance is a prime factor in famine distress. The landholder with unencumbered

land may raise a mortgage to tide over the period of depression; but the 50 per cent. of land-holders whose land is already mortgaged, and the landless labourers cannot do so. Field work comes to an end and wages cease. Under such circumstances the farm labourers in England could not afford to remain idle for a month; and it need not be a matter for surprise that the poorer classes in India cannot afford to remain idle for a year or more. In England, however, the capital of the landlord and the capital of the tenant farmer feel the first brunt of any depression which occurs, and tide the labourers over the crisis, with hardship perhaps, but without the deplorable accompaniments of an Indian famine.

Sinking fund.—Field improvements will go out of order, and implements will wear out. The farmer who does not provide for these contingencies by laying aside a certain sum every year as a sinking fund is bound to find himself in difficulties sooner or later. In considering the question of purchasing expensive machinery the questions of depreciation, repairs and interest are very important. Suppose a man buys a small power cane crushing plant costing Rs. 4,000, he will probably have to allow at least 15 per cent. a year to cover these items; that is to say, he must set aside Rs. 600 a year for the purpose. If he can only run his plant for two months in the year this will amount to a charge of Rs. 10 for every working day. If, however, he can run his plant for eight months in the year the charge on this account per working day will come to only Rs. $2\frac{1}{2}$. It is on such questions that the financial success of machinery of this kind largely depends. The same argument of course holds good in the case of an iron plough, costing Rs. 40 as in the case of more expensive machines. And if the establishment of a sinking fund is necessary to replace working capital laid out in machinery and implements, it is even more imperative in the case of a man who raises a mortgage on his land for unproductive expenditure. If he fails to establish a sinking fund to pay off the mortgage he is almost certain to involve himself in serious difficulties. A sinking fund need not, of course, consist of a stock of cash put

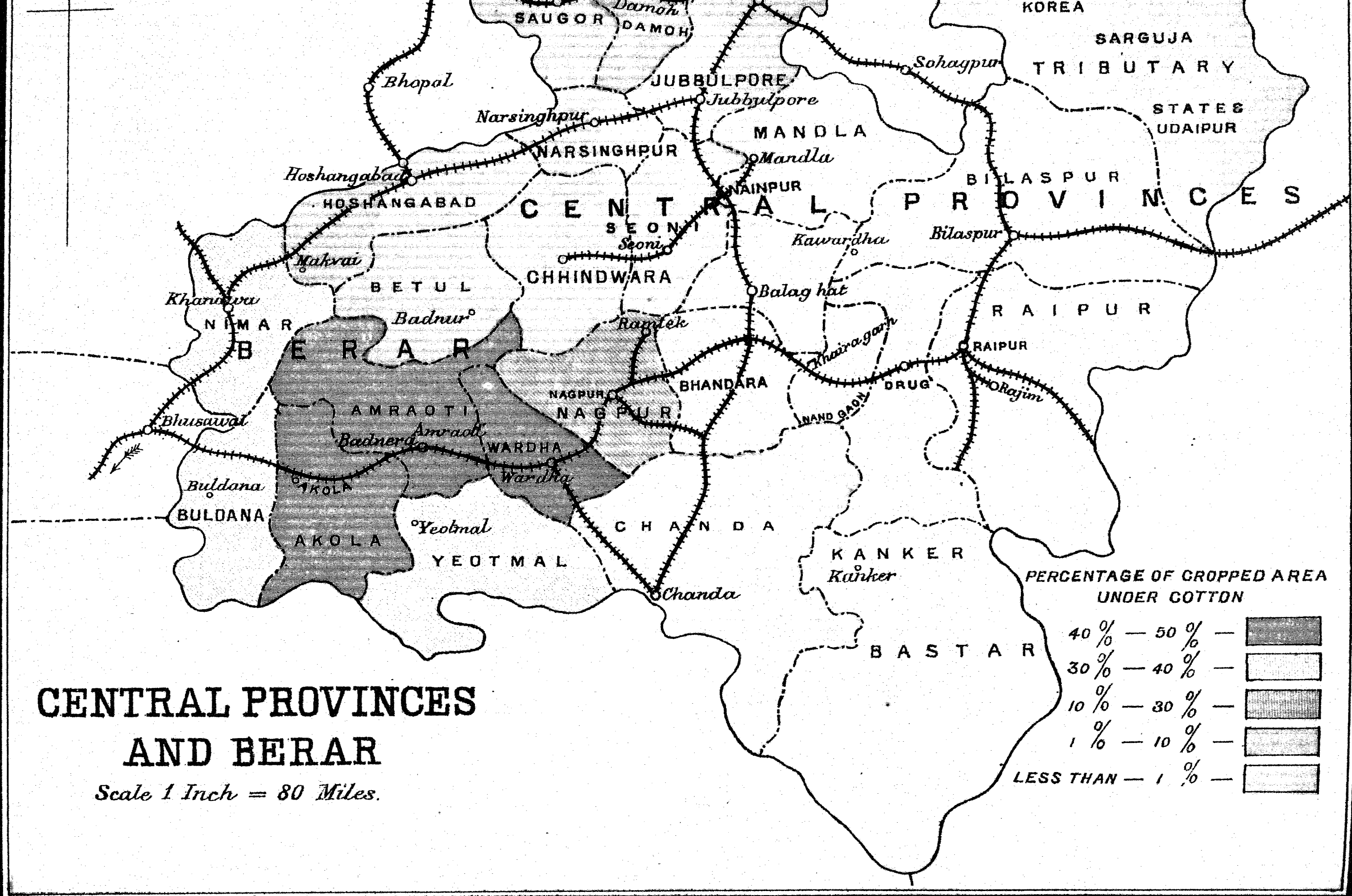
away from year to year. It may be invested in any operation that may be counted on to bring in the money when it is wanted. If the money is wanted in four years, a calf bought for (say) Rs. 20, and reared to be a bullock worth Rs. 100 or more, may represent the sinking fund. If the money is wanted in thirty years a man may plant out a few acres of teak or babul, and realise a good sum for the timber or fuel when the time comes, without more cost to himself than some of his spare time in the interval. The essential thing is that the necessity for a sinking fund should be realised, and the money ear-marked for the purpose.

Insurance.—In western countries a man will insure his stacks against fire, and may insure his live-stock against loss by disease. In India he cannot well do either. In some of the richest parts of the Deccan intentional stack-burning is very common, and, apart from the actual value of the stacks burnt, does much to discourage cultivators from keeping a permanent reserve of fodder. A man who puts up a *Kadbi* stack in his field has given a hostage to his enemies. It is not so much that the Maratha Kunbi is essentially a quarrelsome or mischievous man, as that the small-holdings and infinite sub-divisions of the land, and the absence of fences, afford endless opportunities for disputes. The exact position of a boundary, the trespass of cattle in a standing crop, a question of right of way or water may easily give rise to a dispute which will last for years and involve many stacks in flames. In such cases criminal prosecutions do not serve much to smooth down matters ; and nothing but strong and organised local opinion can suppress the practice of arson which is far too common in many parts of the Deccan.

Even in Europe the insurance of ordinary farm stock is hardly a practical proposition. A particularly valuable animal may be insured ; but the rates offered by Insurance Companies are usually prohibitive in the case of ordinary farm stock. Good results have been obtained in some countries by mutual insurance on co-operative principles. Such a system is, however, not at present applicable to India. All that the Indian cultivator can

lo to secure himself against accidents and damage is to have his house in his fields, so that he may be on the spot to protect his property, a reserve of fodder to make his cattle secure against famine, an enclosed pasture in which he may segregate them when contagious diseases occur, and an irrigation well to serve as an insurance against unemployment in the dry season.

Conclusion.—The most important points have now been considered in connection with the land, the cultivators and the resources which they have or should have at their disposal. There are many important matters to which no reference has been made, such as the question of markets and prices, the necessity for keeping careful farm accounts, and the advantages of co-operative credit. Such questions are of vital importance to the farmer; but are beyond the scope laid down for this article. Where statistics have been given it will be noticed that they relate to classes or to large tracts rather than to individuals. Writers on agricultural economics of other countries commonly illustrate their arguments by giving detailed figures for some farm or estate, and inform the reader that these figures have been obtained from a careful study of the accounts for twenty or thirty years of such and such an estate. In the Deccan it is impossible, or at any rate very difficult to find any accounts of this nature. It is quite possible, however, for anyone who sets about it to collect detailed facts and figures of the nature indicated; and there must be many men from our agricultural colleges who are well equipped to collect such. A little precise information so obtained is worth more than any amount of theory; and if this article results in inducing anyone to undertake such enquiry its object will have been fully gained.



CENTRAL PROVINCES AND BERAR

Scale 1 Inch = 80 Miles.

LITHO BY THACKER, SPINK & CO., CALCUTTA.

COTTON CULTIVATION IN THE CENTRAL PROVINCES AND BERAR STUDIED FROM AN ECONOMIC ASPECT.

By D. CLOUSTON, M.A., B.SC.,

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No crop in the Central Provinces and Berar has received more attention within the last half century than cotton. Within that time the mill consumption of the raw material in Great Britain, America, India and the Continent has increased enormously. There has been considerable variation in the prices from year to year, but they have always remained sufficiently high to make the cultivation of this crop more profitable than that of any other grown in the cotton tract. Bumper crops in India itself have little effect in lowering prices, as the world's supply of the raw material is never quite equal to the demand. Prices have, therefore, remained high, and the wealth amassed in the cotton tract of these Provinces has been very considerable. Wealth has brought in its train many desirable features : it has raised the standard of comfort of the whole population of the tract. Their homesteads are commodious and comfortable, and their cattle are the best to be found in the Provinces. The people are better educated, too, and more enterprising.

The area under cotton, which in 1868-69 was only 2,037,617 acres, had increased to 4,176,561 acres 40 years later (1908-09) : while in 1909-10 it had topped $4\frac{1}{4}$ million acres. The great increase in the area has been largely at the expense of wheat and millets. The rapid expansion in the cultivation of this staple has, in no small degree, been due to the improved railway facilities which have been introduced within the last half century.

Previous to that time the Central Provinces and Berar were almost inaccessible. The two great cotton marts outside the Provinces were Bombay and Mirzapur on the Ganges, to which cotton was carried by road by the Banjaras. The load (bojha), of about 240lbs. consisted of two loose bags slung pannier-fashion on a bullock's back. The cost of transport in this way often exceeded half the value of the cotton. Much loss was suffered in transit, too, for the cotton was eaten by the bullocks, stolen by the drivers and damaged by the dust. The dirty state in which this fibre had been exported had long been a cause of complaint among English mill-owners. Previous to that time little inducement had been offered to the grower to supply clean cotton, as no more was given for clean samples than for dirty ones. The ryot was, it is said, in the habit of sowing his cotton broadcast in certain districts as a mixture with *tur*, *juar* and other crops; he seldom did any weeding and did not start picking till all the bolls had matured. The village *bania* as middleman adulterated his purchases with cotton seed, earth and water; there were as yet no European agents stationed in the Provinces to set the standard of honesty in the trade. The exporter, who was directly interested in getting cotton of good quality, was stationed in one of the big marts and never came into direct touch with the producer, who, therefore, remained in ignorance of his requirements as to quality. It is not surprising that under these conditions Indian cotton became a byword among English mill-owners, whose opinion was that it would never be used by them, except as a make-shift in the event of a shortage in the American supply.

The first real attempt at improvement of this staple in these Provinces dates from 1866, when Mr. Rivett Carnac was appointed Cotton Commissioner, (i) to introduce foreign staples, (ii) to improve the indigenous plant, and (iii) to watch over all affairs relating to cotton and to further, so far as might be legitimately possible, all interests connected therewith. At this time the cottons of the Central Provinces and Berar were classified as Chanda *jari*, *bani* or Hinganghat and Berar *jari* or

oomras. Chanda *jari* and *bani* were different names for the same variety, which was known as Chanda *jari* when grown as a cold weather crop in the district of that name, and as *bani* or Hinganghat when sown in other parts of the cotton tract in the beginning of the rains. The staple of this cotton was described 40 years ago as being fine and silky and quite suitable for the English mills—being nearly equal to middling American. It is interesting to note that samples of the selected *bani* now grown on the Akola Farm have this year been valued at 8·40*d.* per lb., when middling American was selling at 8·07*d.*, which proves that this, our long-stapled cotton, has been improving rather than deteriorating in the quality of its staple. Berar *jari* or *oomras* was slightly inferior to Hinganghat: the name was applied very possibly to all cottons containing a mixture of *bani* and the finer types of *jari.* The Cotton Commissioner decided to concentrate his attention on the improvement of *bani* or Hinganghat mainly, and to improve it by seed selection. Large quantities of Hinganghat seed from the locality of the same name were sent to Berar, Nimar, Jubbulpore and Chhattisgarh. as well as to other Provinces. In 1867, 855 tons of seed of this variety were distributed. The results were disappointing: *bani* did badly in most places and from the selection of seed no results of proved value were obtained. Trials made with American cottons at this time proved equally unsatisfactory. Though grown with great care, they gave poor yields of lint and the fibre was weak. The efforts made to facilitate transport, however, were much more successful. Owing largely to the exertions of the Cotton Commissioner the rolling-stock of the country was increased, new branch lines were opened, suitable yards for storing cotton were provided, and baling presses were introduced. Though the highest expectations formed at the period of the American war were hardly fulfilled, the course of the cotton trade was, after the first five years, one of steady progress : gins and factories sprang up one after another, and the control of the trade tended steadily towards Indian hands, the pioneer European firms dropping out one after another.

The next important attempt at improvements dates from the year 1904, when the Government of India, in response to an appeal from the British Cotton Growing Association, urged Provincial Governments to take up the question of cotton improvement once more, and suggested the following lines on which it might be carried out. (i) The botanical examination and classification of all existing varieties of cotton, both wild and cultivated. (ii) The introduction of better varieties and improved methods of cultivation. (iii) The provision and distribution of good seed of the varieties ordinarily grown. Steps were again taken in these Provinces to improve this staple; but, strange to say, forgetful of the failures of the past an attempt was made once more to push *bani* at the expense of *jari*, which needless to say once more ended in failure. Very few cultivators could be induced to purchase *bani* seed, which the Department had collected for distribution, and those who did were dissatisfied with the poor yields of lint obtained.

In 1906 it was decided to work out a scheme of improvement on scientific and economic lines with the sole aim in view of benefiting the grower. The different indigenous races were classified, and plant-to-plant selection was started in the case of each. Exotic varieties were freely tried, and field experiments were started, designed to ascertain the relative values, from an economic aspect, of these, and of the indigenous cottons.

The result of the classification of the cottons grown in all the cotton-growing taluks showed that the so-called *jari*, the almost universally prevailing type, consisted of a heterogeneous mixture of different races—the plants of which differ greatly in their habit of growth and in the quality and quantity of their lint. In the classification I was guided by the work previously done by Prof. Gammie whose assistance throughout has been invaluable. The character of the mixture was found to vary greatly in different parts of the Provinces. In the Tapti valley and Nimar the finer types, *viz.*, *malvensis* and *vera* predominate; in

quality the lint of this mixture is probably very similar to that of the *jari* or *oomras* grown 50 years ago. In the South including all Berar, where cotton cultivation is more advanced and the cultivators more intelligent, the coarser but more productive types, *viz.*, *rosea* and *rosea cutchica* were found to be in excess: this mixture is commonly known as Berar *jari*, *katevilayti* or *varadi*. Its origin is doubtful: it is said to have been introduced from Khandesh. The classification of 6 typical samples, three from the Central Provinces and three from Berar, is given below :—

Locality.	Percentage of				
	Malvensis & bani.	Vera.	Rosea.	R. cutchica.	Upland American.
Hoshangabad, C. P. ...	26	61	12	0	1
Nimar, C. P. ...	38	55	0	5	2
Bhopal ...	57	42	1	0	0
Kelapur, Berar .	14	7	37	26	16
Amraoti, Berar ...	19	22	33	24	2
Ellichpur, Berar ...	16	16	59	8	1

The *jari* types in most cases form at least 90 per cent. of the mixture: the remaining 10 per cent. being made up of American Upland varieties, locally known as *gogli* kapas and *bani*. These cottons vary greatly in the quality of their staple and in their percentage of lint to seed. The lint of *buri* and *bani* is nearly 1″ in length, while that of the *roseas* is but little more than $\frac{1}{2}$″. Rosea gives 39 per cent. of lint to seed, while *bani* gives 26 per cent. only. As it was found difficult to discriminate between *bani* and *malvensis*, when there was no lint available, they have been classed together. The former, however, forms only a negligible part of the mixture except in a narrow strip of country bordering on the Nizam's Dominions and far from the railway. The repeated attempts made to restore its pristine glory have failed, because the ryot knows that it is a poor yielder, that it is difficult to pick, as the bolls are so small, and the plant so tall and straggly, and

that it is less hardy than *katevilayti.* The percentage of exotic cotton of the Upland type in the mixture varies from 1 to as high as 15 per cent.; but it generally falls below 2 per cent. A trial of numerous exotic varieties resulted in *buri* being selected as the most promising. It has since been proved to be immune to wilt disease, and to be more suitable than *jari* for districts where the rainfall is high.

In the past far too much stress has been laid on the importance of quality of staple as opposed to quantity. In the absence of accurate knowledge as to the outturn per acre, ginning percentages, and relative values of the lint of the different races grown, the methods of improvement adopted were largely based on the requirements of Lancashire Mills. What was good for the ryot was lost sight of. After having gained a fuller experience we are compelled to admit that, under present conditions, quantity is a more important consideration than quality, and that over $\frac{9}{10}$ of the cotton area *rosea* is the variety which will pay best. Many buyers never look at the length of the staple at all; those who do, pay more attention to such good qualities in the lint, as "freedom from dirt," "bulk," "colour" and a high ginning percentage, than to length of staple. This is easily understood when one takes into account the great demand there is for short-stapled Indian cotton in Europe and Japan. To get the full market value for a long-stapled cotton in India it must be sent to an agent who has a special purpose for lint of that class. The grower seldom has the business acumen to do this, and therefore loses heavily when he grows a cotton of superior staple; but, even if the full market value were paid, it would be exceedingly hard to find any long-stapled cotton that would compete with *rosea,* which gives a heavy yield of cotton of a kind which is much in demand. In these Provinces arrangements have been made by the Department of Agriculture to collect and sell the long-stapled cotton grown to the Empress Mills, Nagpur. Though the prices paid by the Manager, Khan Bahadur Bezonji, compare very favourably with the valuations of the same cottons in Manchester, it is

evident from the statement below that, even after making these rather troublesome commercial arrangements in the interests of the grower, *rosea*, on account of its yield and very high ginning percentage, is easily the most profitable variety for the cultivator to grow.

Variety.	Average yield for 4 years in lbs. per acre.			Value at this year's prices in Nagpur.
	Of Kapas.	Of lint.	Of seed.	
				Rs. As.
G. Neglectum malvensis ...	373	112	261	57 5
,, ,, vera ...	343	115	228	51 11
,, ,, rosea ...	402	161	241	69 14
,, ,, rosea cutchica ...	412	150	262	66 0
Berar *Jari*	371	132	239	58 5
G. Hirsutum (*buri*)	303	100	203	57 15
G. Indicum (*bani*)	255	74	181	44 3

It is certain that large quantities of such long-stapled cottons as *bani* and *buri*, which Lancashire requires, could be grown in the Central Provinces and Berar should the prices paid for the lint prove remunerative to the grower. At present they do not, except under the very special conditions to be noted later. It will be gathered from the statement below that, if we were to deal directly with Lancashire instead of disposing of the lint locally, the price realised for our short-stapled cotton relative to that of middling American, would be even higher than the trade pays for it here, and that to substitute a long-stapled cotton for it would, under these circumstances, prove still less remunerative for the cultivator. By exporting his cotton to Lancashire he would, under the most favourable conditions, get about 33 per cent. more for a long-stapled cotton such as *bani* than for his short-stapled *rosea ;* but the outturn of lint of the latter would, on the other hand, exceed that of the former by about 117 per. cent., so that, if he were to grow and

export *bani* at present prices, it would be at a comparatively heavy loss.

Variety.	Valuation of lint per lb. in December 1910 by— Manager, Empress Mills, Nagpur.	Wolstenholme and Holland, Liverpool.	Gaddum & Co., Manchester.	Middling American.
Rosea	6·49*d.*	7*d.*	6·75*d.*	8·07*d.*
Malvensis	7·42*d.*	8·20*d.*	7·75*d.*—8*d.*	
Buri	8·67*d.*	7·90*d.*—8*d.*	8*d.*—8·25*d.*	
Bani	8·81*d.*	8·40*d.*	8*d.*—8·25*d.*	

The purchaser pays the same price for the lint of pure *rosea* as for that of the Berar *jari* or *katevilayti* now grown over nearly all the cotton tract; but *rosea* gives a ginning percentage of 39, while in the statement below, kindly supplied by the Manager, Empress Mills, Nagpur, it will be seen that for Berar *jari* the percentage for the past three years has been about 35 only: so that *rosea* will give 10 per cent. more lint than the mixture at present grown.

	Ginning percentages obtained at factories. 1908-09.	1909 10.	1910-11.
Yeotmal	35·17	34·16	33·85
Akola	35·00	35·43	34·38
Amraoti	...	35·71	35·40
Nagpur	35·07	35·77	34.65
Wardha	34·33	35·10	34·29

Rosea is a hardy variety and therefore suffers less than others from the vicissitudes of the climate and the cracking of our black cotton soil; it is the earliest, too, of all the races grown, and its seed gives the highest germinating percentage. It is capable of great improvement in its ginning percentage by plant-to-plant selection. The selected strain which is now being propagated on the seed farms has given an average of 40·3 per cent. of lint. If it were possible to substitute *rosea* for the *katevilayti* now grown, the higher ginning percentage alone

would in a normal year result in an increase in the Central Provinces and Berar of 51,000,000 lbs. of lint. We believe that this is possible and that to effect it merely requires time and organisation, as the cultivators everywhere are clamouring for the seed.

At present prices there is no possibility of growing *bani*, except at a comparative loss, owing to its low ginning percentage. An effort has been made to raise it by selection, and one strain has been improved to the extent that it gives 29 per cent. of lint; but even at that it is hopeless to think of growing it at a profit.

Rosea cutchica is slightly inferior in the quality of its staple to *rosea* and gives from 2 to 3 per cent. less lint.

Malvensis and *vera* give about the same outturn of lint, which is nearly equal in quality to that of *bani*. There is great variation in the quality and percentage of lint of different strains of *malvensis*, and it is therefore believed that there is much scope for that reason for its further improvement.

At present prices it pays to grow *buri* in fields where *deshi* cotton is subject to wilt disease, and this is being done. Many cultivators who have tried it have found that it pays, too, when grown in the well-manured *khari* soil found near the villages. In the rice tract where the rainfall is high, it has done distinctly better than *deshi* cotton.

Plant-to-plant selection of all these different cottons has been carried on continuously during the last 5 years and all the seed sown on the experimental farms has been propagated in each case from a single mother plant. The seed of these selected strains of *rosea*, *buri* and *malvensis* is supplied to the different private seed farms whose owners in turn distribute it to the cultivators. From the experimental and seed farms 120,000 lbs. of seed were distributed last year; about 150,000 lbs. will be distributed this year; while next year, if the crop is a normal one, the distribution will run up to at least 200,000 lbs. There are already 42 of these seed farms in existence, scattered over 16 taluks. Selected seed will continue to be supplied to

these from the experimental farms, where selection is carefully supervised. The owners of seed farms fix their own rates and arrange for the sale and distribution of their own seed: the Department of Agriculture advertises it for them as widely as possible. Till this year, the selected seed for these farms was supplied by the Department free of cost; as they have now become popular institutions, and as the merits of seed selection are becoming more widely appreciated, those who have started new farms this year have agreed to pay the full market price for the Department's selected seed. All these farms will be run on that footing next year. They will therefore be entirely self-supporting in future, and the duty of the Department regarding them will consist in supervision with the view of ensuring honest dealing, in widening the distribution of seed of the variety specially suited to the locality, in keeping in touch with the owner, and in popularising and extending the system of distribution to other centres. The system is based on the assumption that the owners, nearly all of whom are enlightened members of the Agricultural Associations, are sufficiently honest to sell as selected seed only that which they have raised each year from the improved strains supplied by the Department. The seed supplied to them being of pure strains, it necessarily follows that, in the event of their adulterating it with their own inferior seed, their sins will find them out in the mixed crop raised from it, and that they will soon lose any reputation they may have gained as seedsmen. No such case of adulteration has yet been reported, and we believe that, by exercising efficient supervision, we are in a position to put an end to the practice, should it arise.

The greatest difficulty of all is that of getting the *kapas* ginned without injuring the quality of the seed. Up to the present nearly all the seed has been hand-ginned. As these farms have increased in number, however, great difficulty has been experienced in getting sufficient labour at the proper season. During the picking season, *i.e.*, from October till January, the women coolies are employed in the juar and cotton harvest, and

the seed-grower has therefore to store his *kapas* till the slack season comes round which coincides with the beginning of the hot weather. By that time the price of lint has generally fallen; moreover, the buyer reduces the price still further, on the ground that the cotton has been hand-ginned and is therefore 'dirty.' The grower has still another difficulty to contend with: in the event of plague breaking out in his village, flea-infected plague rats sometimes harbour in the *kapas* and die there. In the light of these facts it has been decided to get the work done in future by power rather than hand gins. All the seed cotton of the Experimental Farm, Akola, has been ginned for the last 4 years on two Platt's gins driven at a slow speed by a small 5 H. P. steam engine. The germinating percentage of the seed ginned in this way is as high as that of hand-ginned seed. Arrangements are now being made to set up similar ginning plants but with an oil instead of a steam engine. We thus hope to have the whole cotton belt studded with hundreds of village seed farms, with small central ginning factories here and there, capable of dealing with all the selected cotton grown thereon. These farms will also continue to serve as centres at which seed of new varieties will be grown for distribution. Of *buri*, the new variety recommended for certain classes of soil, seed for 3,000 acres was distributed in this way last year: while this year twice that quantity will be dealt with.

We believe that a great and permanent improvement of cotton can be effected by working thus *from within*. The trial of exotic varieties will be continued, but here the difficulties in the way of attaining success are greater owing to the soil and climatic conditions being unsuitable for long season cottons. The rainfall of the cotton tract ranges from 30″ to 45″ annually—nearly all of which is obtained during the first three months of the growing season, *i.e.*, from the end of June till the end of September. After this the dry weather sets in and exotic cottons suffer from "red-leaf blight." Sometimes, too, they are still further damaged by frost in December or January. Requiring as they do a longer growing season, they are subject to

forms of damage which our indigenous varieties, being earlier and hardier, escape. Of the exotic varieties tried up to date, *buri* is by far the most promising. It is comparatively early. It is, moreover, immune to wilt disease, and therefore meets a distinct want in this part of India, where, owing to continuous cropping with cotton, this disease is in places becoming serious.

THE INTRODUCTION AND SPREAD OF CAMBODIA COTTON IN THE MADRAS PRESIDENCY.

By H. SAMPSON, B.Sc., F.H.A.S., F.B.S.E.,

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The introduction of Cambodia cotton into the Madras Presidency is perhaps one of the most striking instances in India of how readily the ryot will take up a new cultivation, if once he is satisfied that it pays him to do so. In this case, it is still more remarkable because cotton is no new crop to the ryot and the cultivation of this Cambodia cotton is very different to the methods of cotton cultivation known for generations to the ryots of the Southern Districts. The indigenous cotton has always been essentially a rain-fed crop of the black cotton soil. This, in the dry climate of the south, cannot stand heavy manuring which tends to keep the root system near the surface. Cambodia cotton, however, if it is to pay, has to be grown as an irrigated crop on heavily-manured soil, and if anyone had five years ago told the ryots of Tinnevelly, Ramnad and Madura, that in five years' time their best garden lands (*i.e.*, heavily-manured made soils under well irrigation) would be sown with cotton as an irrigated crop the very idea would have been laughed to scorn. Yet this is what has happened even to the ousting of such profitable crops as chillies and tobacco.

Cambodia cotton very closely resembles American Upland and is probably of the same species. It is, however, in this climate, much hardier and more vigorous and gives a stronger and fuller lint than either newly introduced American or acclimatised Dharwar American. Its root system closely resembles that of American Upland, *viz.*, a tapering tap-root with strong

feeding roots given off near the surface, and differs greatly from that of the indigenous cottons which have a long slender tap root with very slender feeding roots penetrating deeply into the soil. It can be understood, therefore, why it is that Cambodia responds so readily to irrigation, and how, since the crop is protected from drought, it is possible to manure heavily and obtain very heavy yields, and it can also be understood why this crop, if grown on black cotton soil with the aid of rain alone, cannot resist prolonged drought. On well-manured land under irrigation the yield is usually stated to be from 1,250 to 1,600 lbs. of Kappas and never less; while yields as high as 2,500 lbs. have been reported. With a ginning percentage of 33 to 35% of lint, an acre will, at this rate, give about a bale of lint (500 lbs.) or over.

Cambodia cotton was first introduced into this Presidency by Mr. C. Benson, the late Deputy Director of Agriculture, Madras, who in 1904 obtained a small quantity of seed from Monsieur A. Paulain, the President of the Chamber of Agriculture, Pondicherry. This was sown on the Koilpatti Agricultural Station as a dry crop on black cotton soil. Sixty-four lbs. of Kappas were obtained from an area of 20 acres. This was again grown in 1905 and the following years, but its root habit showed that it was unsuited to black cotton soil in a dry climate. In 1907, a year of heavy showers in the latter part of the picking season, it responded very readily to these and gave a yield greater even than that of the indigenous black cotton soil cottons. Such years, however, are the exception and not the rule.

In 1905, Mr. A. Steel, of Messrs. A. & F. Harvey, Virudupatti, happened to find in a loose bundle of Kappas, some of this same Cambodia Kappas, and he called this cotton "American," it being of the same class as American Upland, by which name it is now known throughout the districts where it is grown —and even on the Liverpool market it is known as "Tinnevelly American." On enquiry as to the origin of the bundle, he learnt that this also came from Pondicherry. Having a

piece of land (black cotton soil) near the Press, he sowed some of the seed in 1905, and in 1906 got a fair yield sufficiently encouraging to make him continue the trial the next year. 1906-07 happened to be a very favourable year for cotton and, as already mentioned, Cambodia cotton yielded well this season at Koilpatti. Even then, in spite of the favourable season, ryots, so Mr. Steel informs me, who saw the crop, suggested that it should be irrigated. Virudupatti being probably the chief centre of the cotton trade for "Tinnevellies" and a place which the cotton-growing ryot frequently visits, was an excellent place for such a promising trial, and there was a regular scramble to get the stock of seed which Mr. Steel had to dispose of. This was sown by ryots on lands which could be commanded by irrigation. The 1907-08 crop amounted in all to 40 bales (of 500 lbs.), and the seed obtained from this was eagerly sought for. Most of it was sold in small lots at fabulous rates, as much as 4 as. a pound being, in some cases, paid for it. In 1909, 1,650 bales were pressed and in 1909-10 the cultivation had spread so rapidly that the crop realised nearly 7,500 bales (of 500 lbs). No definite information is available as to what the 1911 outturn will be, but Mr. Steel estimates this at between 25,000 to 30,000 bales (of 500 lbs.) or about 25 per cent. * of the probable outturn of the Tinnevelly crop. Since Cambodia cotton is not grown on ordinary cotton soil, but on garden and irrigable land, this hardly affects the area or the outturn under ordinary "Tinnevellies."† The outturn of Cambodia cotton may therefore be looked upon as an addition to the ordinary "Tinnevelly" crop.

The cultivation of Cambodia cotton thus, to all intents and purposes, commenced from Virudupatti, though seed has also been distributed from the Koilpatti Agricultural Station to several persons throughout the Presidency and several centres

* The Government final outturn report for ryotwari land of "Tinnevellies" is 42,900 odd bales of 400 lbs., *i.e.*, only 20 per cent. more than Mr. Steel's estimate of the Cambodia outturn.

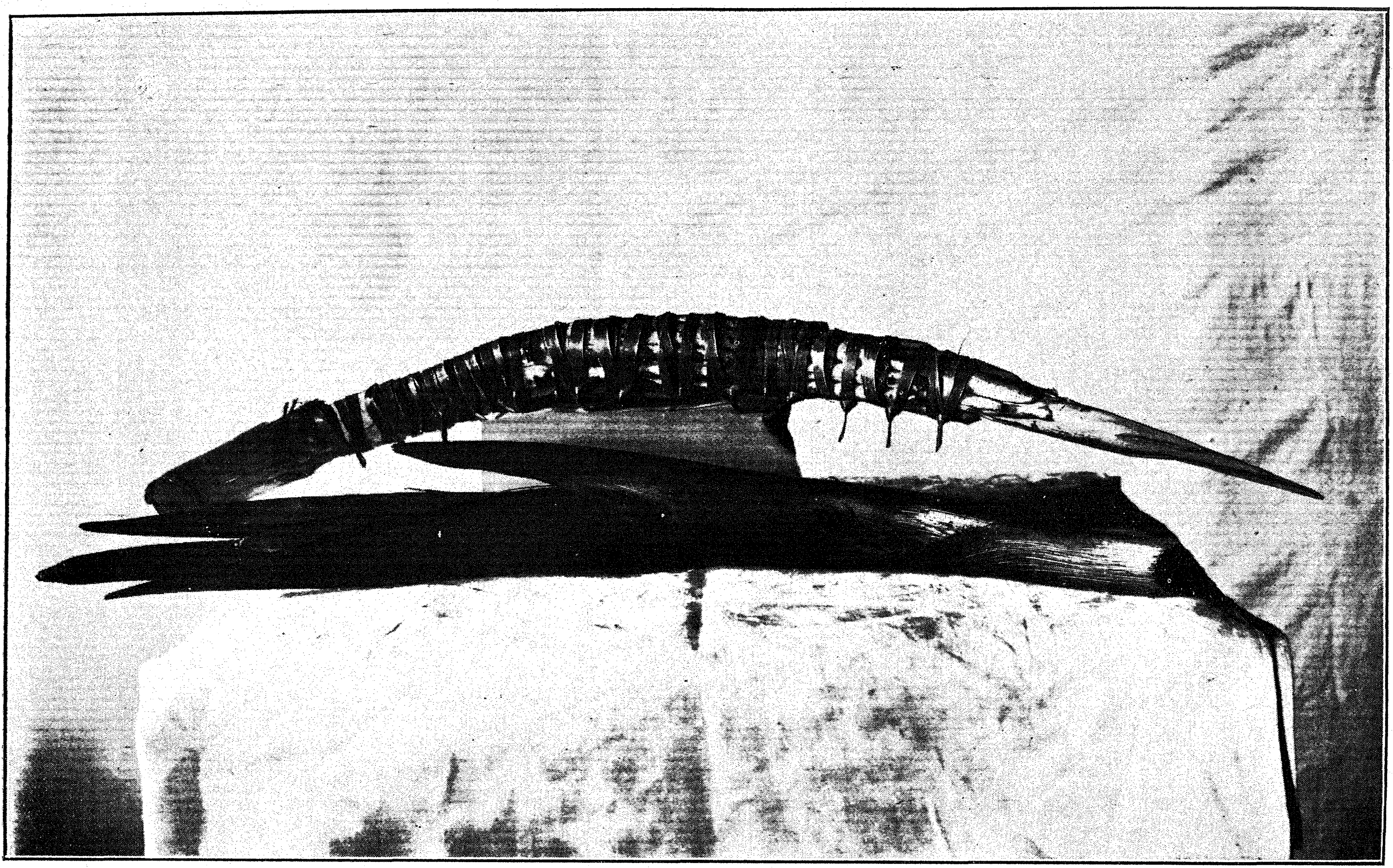
† This does not, however, include Zemindari land and the 25% given above is Mr. Steel's figure for the proportion of Cambodia to total outturn of "Tinnevellies."

of cultivation can be traced to this origin. From Virudupatti it spread chiefly westwards towards Srivilliputtur and from there northwards into Tirumangalam Taluk and the country lying near the Ghauts in the Madura District. Not only is this cotton grown on garden lands, but it also is now largely cultivated on well-drained wet land under tanks and under precarious irrigation sources which are too uncertain to ensure a paddy crop.

1910 has seen a much wider extension. From the south and west of Madura District this cultivation is creeping up into Coimbatore through Palni, and it is also extending to the east and north of Madura District into Trichinopoly. By means of the Agricultural Department this crop is also being introduced into other districts further afield, and seed has been distributed to Trichinopoly, South and North Arcot, Salem and Coimbatore in the south, while it is being tried in several parts of the north of the Presidency. Not only this, but even in Tinnevelly and Ramnad, the original starting point of this crop, wells are on all sides being sunk and garden lands are being made with the primary object of growing Cambodia cotton.

There are certain dangers ahead which, if possible, should be guarded against. One is that this being an irrigated crop, it can be sown sooner and left on the ground longer than the ordinary country cotton, and now the land is no longer left free from cotton from July till September which break did much to keep cotton pests in check. Another danger is in the mixing of country Kappas with Cambodia, and unless buyers protect themselves against this by concerted action, this mixing is bound to increase when the ryot benefits more largely in the higher value of this cotton and the reduction in value from mixing will ultimately be more felt by the ryot than by any one else.

I wish to acknowledge here not only the assistance which Mr. Steel has given in supplying me with figures and information, but also the large share he has had in introducing this cotton to Southern India.



A. J. I.

Tanno or male spadix bandaged up and ready for incision (above).
Ditto, in its natural state, in the sheath (below). (Reduced to $\frac{1}{6}$th).

THE MANUFACTURE OF PALM SUGAR IN UPPER BURMA.

By L. AUBERT, B.A., B.SC.,

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Palm sugar, *tannyet*, or,—if the Indian name be more familiar,—*jaggery* is obtained from the inflorescences of the Palmyra tree (*Borassus flabellifer*, Linn.). This palm (Burm : *Tanbin*) is well known in Burma and in India, and needs no special description.

Both the male and the female trees are tapped for their juice. from the time the first flowers appear till late in the year. In the male tree (Burm : *Tabo*) the innumerable tiny flowers are borne on a thick cylindrical spadix or flowering branch somewhat resembling finger-like growths twelve to fifteen inches long and given out at the top of the tree. The female tree (Burm : *Tamma*) bears spikes varying from a foot to eighteen inches in length, with the young berries seated all round, as in the cob of the maize plant. Both the palms, male and female, when full grown and healthy, bear from four to five inflorescences in the year, the lower ones blooming earlier, and the higher ones later in the season. The *Tabo*, which blossoms first and gives out a thickly sheathed spadix early in the month of March, opens the toddy season, which is closed late in October, when the berries have fully matured on the *Tamma*.

The toddy season thus lasts eight months of the year. It may be divided into three tapping phases or periods, during which the following operations are carried on : the *nuyit* and the *hnyat-thayaung*, on the *Tabo*, the *yaung* and the *thiyin* on the *Tamma*.

The first period of tapping is occupied by the *nuyit*, in the months of March and April. The practised eye of the toddy tree climber has soon fixed on his subjects, and sorted out, in the dense grove, the trees ready for him. The earlier or lower blossoms are selected first, the upper or later ones being left for the second tapping. The tree is climbed, and, with a sharp pointed knife, the external sheaths enclosing the *tanno*,* or male spadix, are removed, and its finger-like ramifications are bandaged up together with strips one-fourth of an inch wide, made from the tender young leaves of the tree. In a couple of days the *tanno* is ready for tapping. About one-third of the total length of the *tanno*, from the tip, is removed with an extremely sharp knife, the *dannee*, generally in the cool of the evening. No sap or juice flows for about 24 hours. The next day a small earthen vessel is slung up the tree and attached to the *tanno* to receive the exuding juice, which flows, at first, drop by drop; the flow gradually increasing in quantity, until the supply is exhausted, in about 40 days. The tree is climbed morning and evening. Each time the vessel attached on the previous climbing is removed; a slight incision made, a thin slice only taken off the pointed end of the *tanno*, and a fresh empty vessel,—prepared as described hereafter,—is slung up in the place of the first one taken down.

The second tapping, in May and June, consists of the *hnyat-thayaung* and of the *yaung*, the two operations being carried on simultaneously. The output of the *Tabo* is at full flow, and the *Tamma* is ready for its first operation. The sheaths protecting the upper inflorescences of the *Tabo* have by now dropped off; those still adhering being removed with a sharp knife, *dabwin*. The bared *tanno* is squeezed with a pair of large wooden pincers, a *hnyat*, for a few minutes the first day, and again after an interval of 48 hours. The *tanno*, with all its ramifications, is then bandaged up with strips of the leaf in the manner described for the *nuyit* operation. The first incision is made after an interval of 48 hours and an earthen pot, *mye-o*, slung up in the

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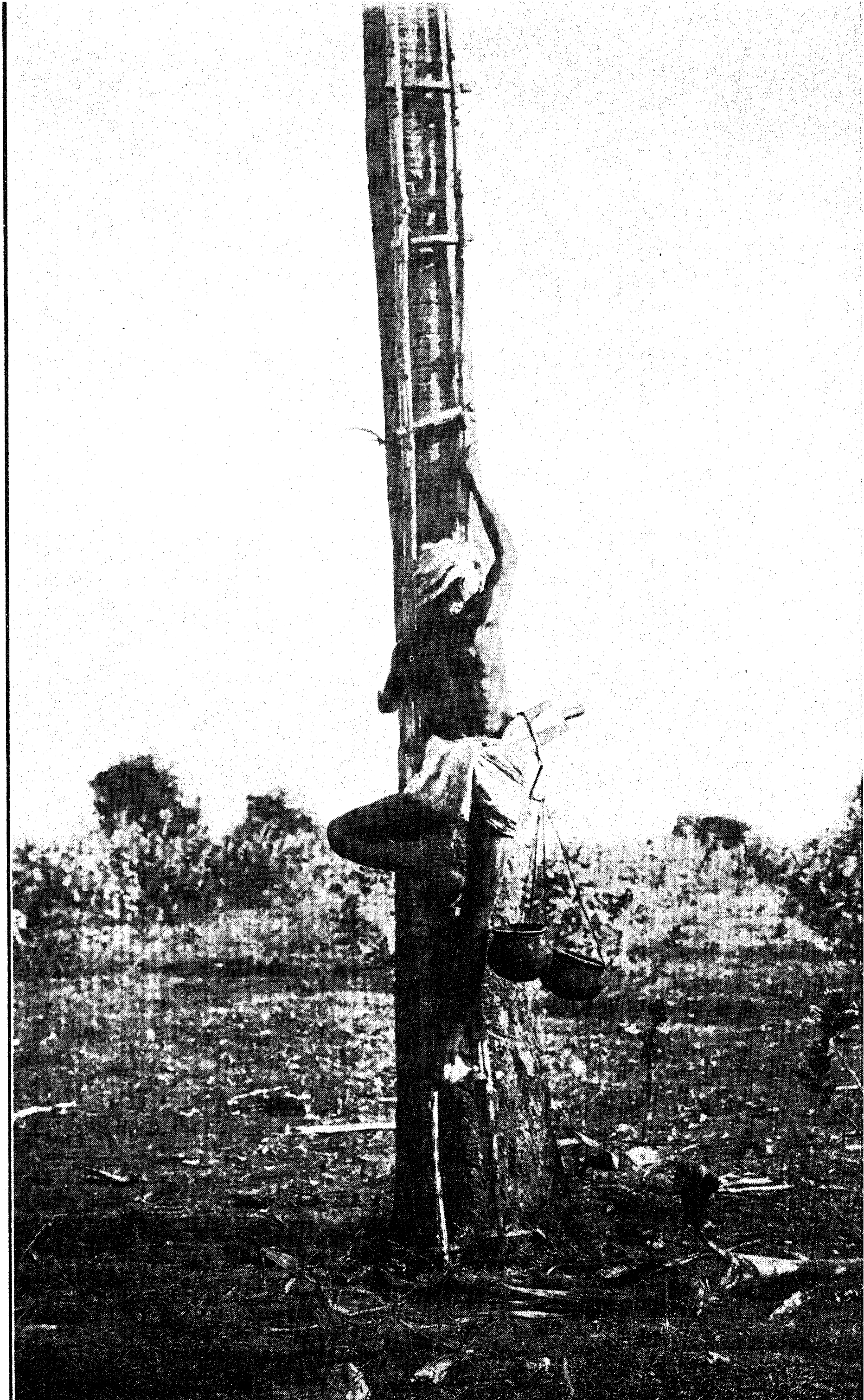
* Literally, the udder of the tree.



A. J. I. TODDY PALM CLIMBER, *Tanthama*.

usual way. From this moment onwards, a fresh but slight incision must be made at every climbing, morning and evening, and a newly prepared *mye-o* slung up at each time.

While this operation of the *hnyatthayaung* is performed daily on the male tree, the operation of the *yaung*, in the early stage of the female inflorescence, is also in progress. When the young berries on the spike, *tadigaing*, are still about the size of a walnut, this *tadigaing* is beaten lightly for a few minutes the first day, with a small iron hammer, the *tadu*. This gentle hammering, with a view to bruise and relax the tissues, is done on the bare parts of the fruiting peduncle, in the interstices between the berries. The operation is repeated after an interval of two nights, and the first incision is made with the *dannee*, after another interval of 48 hours. The usual earthen *mye-o* is slung up at the tip of the spike operated on, to catch the exuding sap. Both the incision and the receptacle for the juice have to be renewed in the usual manner at each climbing.

The two operations described above have taken us to the middle of the month of June, the end of the second period of tapping. The supply of sap from the *Tabo* has stopped by now, but the *Tamma*, the more valuable of the two for its longer and richer output in juice, is in full flow. This is the time for the *thiyin*, the third period, which lasts as long as the two others put together, closing late in October. Like the *hnyatthayaung* on the male palm, the *thiyin* on the female tree is performed on the upper and later inflorescences. The spikes are gently hammered with a *tadu*, in exactly the same manner as done for the previous operation of the *yaung*, but the first incision is made about a month after, in July, *Wazo*, when the berries are fully developed and have begun to mature. A slight incision has to be made hereafter at each climbing, and the vessel renewed twice daily, morning and evening. If all goes well and the tree is healthy, the flow of juice will go on increasing until the end of the season.

The life of the toddy palm climber, *tanthama*, is a hard one, badly remunerated, and attended often with sad accidents. Toddy tree climbers in Burma form a special class or caste ; and

the profession, which requires a patient and daily practice, is handed down from father to son. An ordinary climber is able to climb, twice a day, 40 to 50 trees of a height averaging from 60 to 80 feet each, between daybreak and nine o'clock in the early morning, and again in the afternoon, between three o'clock and sunset—that is, 80 to a 100 trees in a season; 40 to 50 *Tabos* in the early part, and the same number of *Tammas* during the later period. In these few hours, he replaces, at each climbing, the earthen pots, *mye-os*, fixed up on the previous occasion, for new ones prepared and placed in readiness beforehand by his wife and children at the foot of each tree to be climbed. He also hands them the vessels brought down containing the juice extracted. He carries attached to his waist his knife in a wooden sheath to which is also hooked the vessel he takes up or brings down with him at each climb.

The instruments of the toddy palm climber are varied, and consist of the following:—

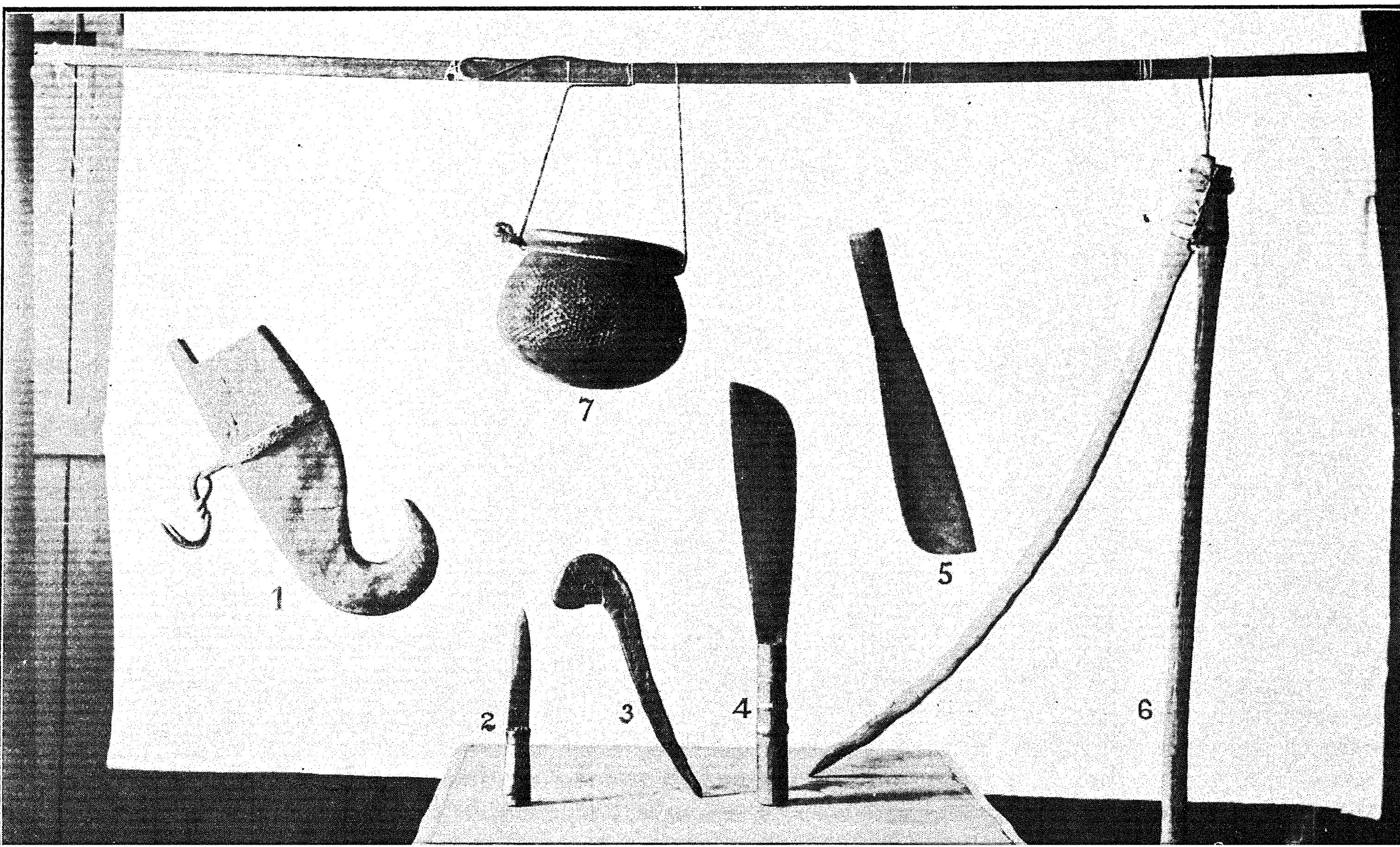
The *dachun* is a knife 18 inches long, used for trimming and smoothing from asperities the stems of the trees to be climbed, and for removing the still adhering remnants of the old dried-up petioles, before climbing can be attempted.

The *dabwin* is a small knife, 8 inches long, used at the *nuyit* operation for removing the sheaths enclosing the inflorescence, and for cutting strips of the tender leaves to bandage up the *tanno*.

The *dannee*, the most important of the series, is a very sharp knife, about 14″ long, used for all incisions. It is the climber's *vade mecum*, and is placed into a wooden sheath attached to his waist. The lower extremity of the sheath is fitted with iron hooks to which are slung the pots to be carried up or brought down the tree.

A pair of wooden pincers, 3 feet long, made of two outwardly curved pieces of the wood of the *Zibin* (*Zizyphus jujuba*) and used at the second operation on the male tree for squeezing and bruising the *tanno*, is called *hnyat*: from it has been derived the name of *hnyatthayaung*.

PLATE XLIII.



The *tadu*, sometimes called *sauk-khauk*, is a recurved iron hammer, a foot long, used to beat lightly the *tadigaing*, or spike bearing the berries at the time of the *yaung* and the *thiyin*.

An earthen vessel, 6 inches in diameter, and of the capacity of 6 pints, slung up to receive the juice after each incision, and to which reference has been made several times already, is called *mye-o*. Each palm climber stocks 300 or 400 of these for the season. They are made locally and cost Rs. 2 a hundred.

While the male member of the family attends to the tree and to the extraction of the sap, his wife and children are not idle. They too have their share of labour and their daily duties. The children prepare the *mye-os* for the next climbing and place them at the foot of each tree, beforehand, carrying back to the hut the vessels containing the juice brought down. There, the mother attends to the emptying of these vessels into large earthen cauldrons. She also attends to the boiling of the juice and to the manufacture of the *tannyet*, a general name for all qualities of palm sugar.

The preparation of the *mye-os*, before being used at first, and each time before they are attached to the tree, is an important operation on which depends greatly the quality and the flavour of the syrup. When newly bought, the pots are washed and exposed, still wet, in rows, with their openings towards a fire made of dried branches and leaves; in short, they are smoked for about ten minutes. Hereafter, each *mye-o* used is washed and dried in a similar manner, at least, once a day. Just before being placed in readiness to be slung up, a few chips of the bark of the *Thitya* tree (*Shorea robusta*), are dropped into each empty vessel. The reaction of this bark has the object to retard fermentation and seems superior to lime in its effect, as the juice retains its full amount of saccharine matter, and does not deteriorate in the least.

The boiling of the juice and the manufacture of the sugar, as noted above, are exclusively the part of the toddy climber's wife. Five large earthen cauldrons, *pyin-os*, of a capacity of $2\frac{1}{4}$

gallons each, are kept on the fire continuously. Into the first one, the day's fresh supply is poured, boiled late in the evening to full ebullition, in order to prevent fermentation, and is then put by until the next morning; when it is again boiled down to about one-third of the original quantity, until it takes the consistence of syrup. It is then transferred to the second cauldron to make room for a fresh supply.* In the remaining cauldrons, the syrup is meanwhile being reduced to treacle; the contents of the third cauldron being added to the fourth, and, in turn, to the last one, until the latter has been filled. At this stage, the treacle is taken off the fire, stirred for several hours with a long wooden spoon, the *yaungma*, and allowed to cool. When sufficiently cool to be handled, portions of the half solidified mass are taken out with a *yaukchit*,—a small flat wooden spatula,—and are quickly rolled into balls with the hands slightly moistened with water. These balls are then placed on a clean mat or on a tray, and spread out to dry in the sun. We have here the common, brown unrefined sugar generally used and exported, the *tannyet-longyan*. There are two better qualities besides; the *tannyet-lonthé* and the *tannyet-pyuzôk*, classed and valued according to their degree of purity and refinement; the latter being of a whitish colour. This is made to order only, in small quantities at a time, and is not exported.

Ten *mye-os*† of juice yield 2 viss of *tannyet-longyan*;‡ that is to say, a gallon of raw juice will give about a pound of unrefined sugar. This quantity varies for the two better qualities in proportion with the degree of refinement, the yield being about two-thirds less for the superior quality, the *pyuzôk*. A hundred viss of *longyan* sell at Rs. 15 locally. The middle quality, the *lonthé*, fetches Rs. 20 a hundred viss; and the *pyuzôk*, obtainable in small quantities only, is sold at the rate of 4 annas a viss.

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* When in full ebullition, the overflow of the boiling syrup is checked instantly by a pinch of the powdered seed of the castor plant (*Ricinus communis*) rubbed against one side, at the mouth of the cauldron.

† 60 pints.

‡ 7¼ pounds; one viss, 3·63 lbs.

A good average tree returns 10 viss ($36\frac{1}{4}$ lbs.) of *longyan* in a season. The yield in the male and the female trees is much the same, though the *Tabo* flows only for a comparatively short period; the bulk of its supply is given out, at the time of the *hnyatthayaung*. The *Tamma* does not dry up so rapidly. It gives less in a day, but the supply is more even and reliable, and the juice richer in saccharine matter. The ripe fruit, on which cattle are fed in the dry season, and the seed add to its value. The owner's share of the produce from each tree tapped is one-third for the season; or, as generally arranged, he gets a day's yield every three days, the toddy tree climber taking the rest.

The palm sugar producing districts of Upper Burma are the Pakokku, the Lower Chindwin, the Myingyan, the Sagaing and the Meiktila districts. The following are the chief centres of export: Yesagyo, Myaing, Pakokku and Seikpyu, in the Pakokku district; Monywa and Sadon, in the Lower Chindwin; Myingyan, Nyaung-u, Salé, in the Myingyan district; Sagaing and Myinmu, in the Sagaing district; Meiktila and Mahlaing, in the Meiktila district. The average exports from the Pakokku district alone, by the steamers of the Irrawaddy Flotilla Company, for the last nine years, work out to 7,500 tons annually.* It has been estimated that at least an equal quantity is exported in country boats, bringing the annual amount of palm sugar exported from that district to 15,000 tons, in round figures. Exact figures for the other districts mentioned are not available, but the total exports in each individual instance would, in the case of the Lower Chindwin district, stand at about two-thirds of the above given figure; for the Myingyan district, at about one-half only; for the Sagaing and the Meiktila districts, put together, they would not reach above a quarter.

A few remarks may be allowed, in concluding, on the disadvantages of this industry. A fact that cannot escape notice is that palm sugar is manufactured in the districts of the dry zone and that the industry is, in a way, greatly detrimental to those

* Pakokku Settlement Report, para. 17.

districts, from the agricultural point of view, as well as from an economical one—the fuel supply of the future.* It consumes a large amount of fuel and has for centuries led to indiscriminate forest-cutting. Sugar-making has been mentioned as a resource for the peasant to fall back on in bad seasons :† but it is not clear how this could be the case, as the palm trees are generally the property of a well-to-do minority, and toddy climbing is a profession practised in good and bad years alike, requiring a long training and handed down from father to son. That the industry is greatly detrimental, there can be no doubt. For miles around, at the sugar-boiling season, the country is bared of every stick of vegetation that can be found ; so much so, that the people are beginning to awake to the fact that fuel, even for their domestic use, is rapidly becoming scarce. This industry did not grow in a day ; it has been practised from time immemorial. There are indelible marks to show that where now lie vast, sunburnt arid areas, in the past, stood dense virgin forests. The etymology of the name of one of the largest *tannyet* manufacturing centres, Myaing, can confirm the above statement. *Myaing* means "virgin forest,‡" and there are ancient writings to prove that the country around was, at the time of the foundation of this village, clad with dense forest growth ; though, at the present day, the name may sound an irony.

In times of scarcity every second cultivator met with in the jungle blames the rainfall, and often the Government :—crops were abundant and the heavens propitious in the days of his ancestors. But he is blind to the true cause of the evil—their recklessness, and his own, in forest cutting. If not restricted in this inconsiderate timber-wasting by the proclamation of reserved areas, not only will the industry soon be doomed to ruin, but the Burman in these parts will miss even the fuel necessary to cook his daily food.

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* Pakokku Settlement Report, para. 13.

† Pakokku Settlement Report, para. 17.

‡ *Taw-myaing*.

NOTES OF A TOUR IN THE FRUIT, SPICE AND PADDY GROWING TRACTS OF NORTH KANARA, BOMBAY PRESIDENCY.

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Supernumerary Economic Botanist.

THE district of North Kanara is situated about 240 miles south of Bombay and constitutes the southernmost part of the Presidency having been separated from Madras, or South Kanara in 1862 because of its closer trade connection with Bombay. It comprises a belt of country of great variety and richness of scenery with an extreme length of about 110 miles from north to south, a varying breadth of 10 to 60 miles and a total area of 3,910 square miles. Towards the south-west it is bounded by the Arabian Sea, on the north-west by the Portuguese frontier and sea-board territory of Goa, on the north and east by the Belgaum and Dharwar districts of the Bombay Presidency, and on the south-east and south by the State of Mysore and a small portion of the Presidency of Madras. There being no direct railway communication, the most convenient way of approach is by steamer from Bombay to Karwar.

Before proceeding to describe the actual fruit, spice and paddy growing tracts, it would be better to give a general idea of the aspect of the interior which is considered the most picturesque part of the Bombay Presidency.

Aspect.—Extending north and south in the line of the Western Ghâts—an irregular chain of central hills of nearly 2,000 feet altitude known as the Sahyadris—divide the district into two main regions :—

1. A lowland plain and coast tract ;

2. An upland plateau and jungle tract—ordinarily distinguished as: 'below-ghats' and 'above-ghats' respectively.

Sloping from the Sahyadris to the west, are several smaller hill-ranges with numerous isolated spurs. All are densely clothed with magnificent and valuable forest and abound with big game—tiger, panther, wild boar, wild deer (sambhar), etc. Rising in the north and east of the interior, several broad rivers traverse the upland plateau for many miles before hurling themselves in narrow rocky channels over the rugged granite cliffs of the Sahyadris—producing most glorious water-falls. Continuing on their courses through the valleys situated between the westerly-sloping hill ranges, they eventually form extensive winding lagoons which enable small craft to ply to and fro with cargoes of fruit, spices, paddy, timber and general produce.

In the month of May, when the rose, purple and lilac flowers of the "taman" (*Lagerstrœmia reginœ*) are in full bloom on the hill slopes, it is indeed most beautiful to sail up one of those estuaries,—the waters glistening in the sunshine or reflecting the deep blue of the sky and the fruit gardens on either side, with their brick-red soil and long avenues of bright green "arching," plantains and stately coconut palms, surmounted by the towering wooded heights beyond.

Fruit Gardens.—Below-ghats, the best fruit gardens are situated along the banks of the rivers and on the coast land near the base of the hill slopes, while, above-ghats, on the north-western side—nestling in valleys amongst the hills and shrouded in trees—are the famous betel-nut (supari), pepper and spice gardens of Kanara with innumerable and extensive plantain, orange and coconut groves.

The chief kinds of fruit grown and exported are :—

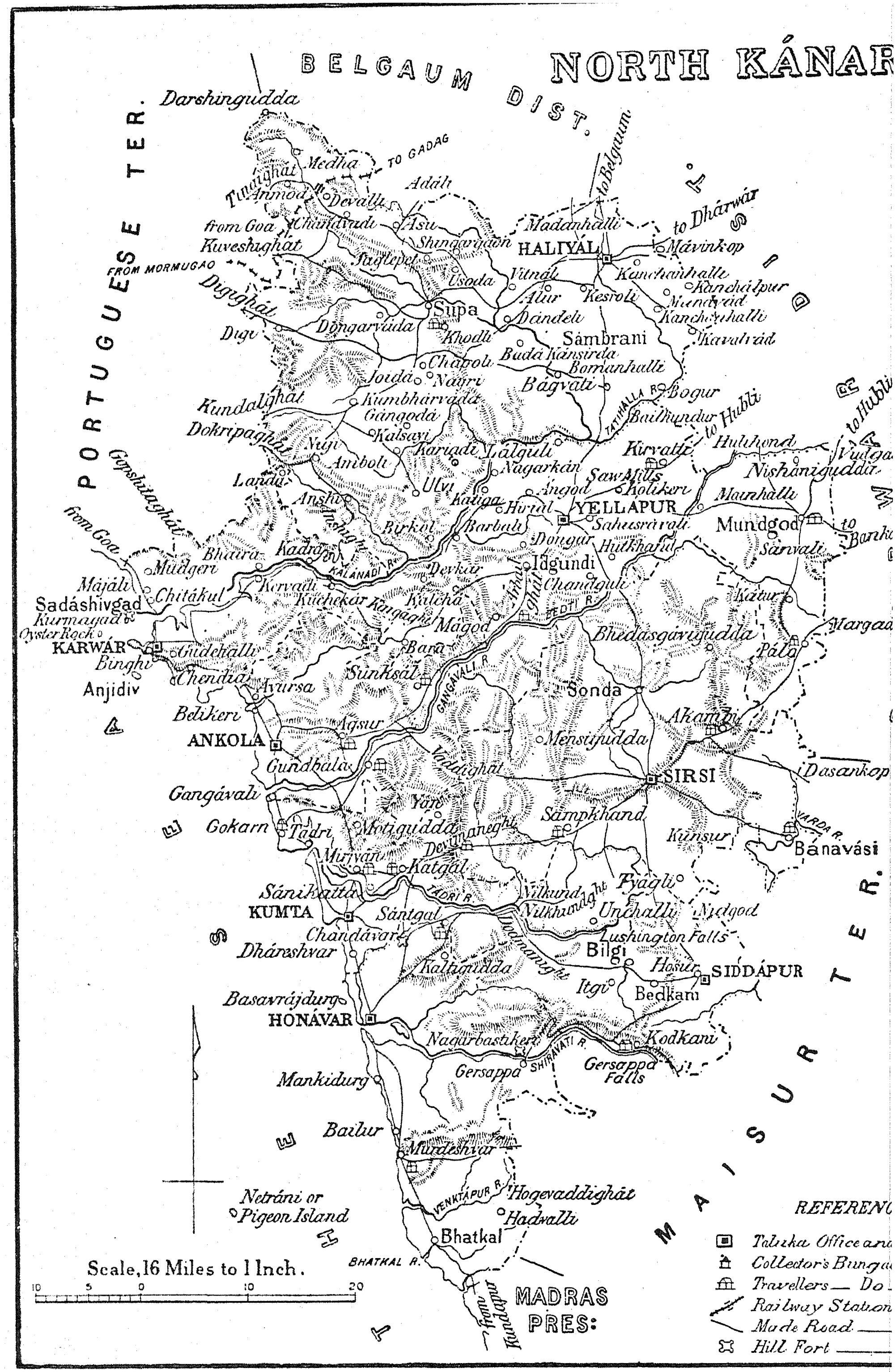
Mango (*Mangifera indica, Linn.*—varieties).

Jack fruit (*Artocarpus integrifolia, Linn.*—vars.).

Cashew nut (*Anacardium occidentale Linn.*—vars.).

Coconut (*Cocos nucifera*—vars.).

Plantain (*Musa sapientum and M. paradisiaca*—vars.).


NORTH KÁNAR
BELGAUM DIST.
PORTUGUESE TER.
MAISUR TER.
MADRAS PRES:
Darshingudda
to Gadag
Medha
Tinaighat
Anmod
Devalli
Adáli
from Goa
Chandvadi
Asu
Kuveshighat
Shingargaon
Madanhalli
to Belgaum
to Dhárwár
HALIYÁL
Mávinkop
from Mormugao
Jaglepet
Usoda
Vitnál
Kanchanhalli
Kanchálpur
Digighat
Supa
Alur
Kesroli
Dandeli
Dongarvada
Khodli
Digi
Sámbrani
Chapoli
Budá Kánsirda
Bomanhalli
Joida
Nágri
Bágvati
Bogur
Kundalighat
Kumbharváda
Gángoda
Tatihalla R.
Bailhundur
to Hubli
Dokripaghat
Kalsayi
Nagi
Amboli
Kariadi
Lálguli
Nagarkán
Kirvatti
Hulihond
Nishániguddá
Landa
Ulvi
Saw Mills
Angod
Holikeri
Mainhalli
Anshi
Anshighat
Kaiga
Hirial
YELLAPUR
Sahasráralli
Mundgod
to Bankápur
Gopshitaghat
from Goa
Birkol
Barbali
Dongar
Hutkhand
Sárvali
Bhaira
Kadra
Mudgeri
Kalanadi R.
Devkar
Idgundi
Májáli
Chitákul
Kervadi
Chandguli
Sadáshivgad
Küchekar
Kalcha
Kangaghat
Bedti R.
Katur
Kurmagad
Oyster Rock
Mágod
Margod
KARWÁR
Gudehalli
Bara
Bhedasgaviguddá
Pála
Binghi
Chendia
Sunksál
Gangavali R.
Anjidiv
Avarsa
Sonda
Belikeri
Agsur
Akamb
ANKOLA
Mensiguddá
Gundbala
Valadighat
SIRSI
Dasankop
Gangávali
Yan
Gokarn
Tadri
Motiguddá
Sámpkhand
Varda R.
Kunsur
Banavási
Devimaneghat
Mirjan
Katgal
Tyagli
Sánikatta
Tadri R.
Nilkund
Nilkhundghat
KUMTA
Sántgal
Unchalli
Nidgod
Chandávar
Lushington Falls
Dhárashvar
Bilgi
Kaltiguddá
Hosur
SIDDÁPUR
Itgi
Bedkani
Basavrájdurg
HONÁVAR
Nagarbastikeri
Shirávati R.
Kodkani
Gersappa
Gersappa Falls
Mankidurg
Bailur
Murdeshvar
Venktápur R.
Hogevaddighát
Netráni or Pigeon Island
Hadvalli
Bhatkal
Bhatkal R.
from Kundapur
Scale, 16 Miles to 1 Inch.
10 5 0 10 20
REFERENC
Taluka Office and
Collector's Bunga
Travellers — Do
Railway Station
Made Road
Hill Fort

Lime (*Citrus medica, Linn.*)—vars. : *limetta* (sweet lime) ; *acida* (sour lime) ; *limonum* (lemon).

Orange (*Citrus aurantium, Linn.*)—vars. : "santra" (round, sweet) ; "ladu" (balloon-shaped,—sweet) ; "bigaradia" (sour).

Pomelo (*Citrus decumana, Linn.*)—vars. : (1) white pulp, (2) red pulp.

Guava (*Psidium guyava, Linn.*)—vars : *pomiferum* (round, red pulp) ; and *pyriferum* (pear-shaped, white pulp.)

Pomegranate (*Punica granatum, Linn.*)

Custard apple (*Anona squamosa, Linn.*)

The following are grown to a small extent but not exported :—

Bullock's heart (*Anona reticulata, Linn.*).
Fig (*Ficus carica, Linn.*—vars.).
Tamarind (*Tamarindus indica*).
Papaya (*Carica papaya, Linn.*—vars.).
Pineapple (*Ananas sativa, Linn.*).
Rose apple (*Eugenia jambosa*).
Jambool (*Syzygium jambolanum*).
Bor or Ber (*Zizyphus jujuba, Lamk*).
Kumrak (*Averrhoa carambola, Linn.*).
Bilimbi (*Averrhoa bilimbi*).
Belgaum walnut (*Aleurites moluccana*).
Indian walnut (*Terminalia catappa*).

The principal sweet mango varieties are grafts from the famous Goa mangoes, and include the following, arranged in order of superiority :—

1. "Fernandin ;" 2. "Ishad" ("Kala" and "Ujla" ;) 3 "Kariyel ;" 4. "Mushrad ;" 5. "Aphoos" or "Alphonse."

The trees generally come into bearing about the 5th or 6th year after planting, but are not full-grown till 15 years old. The average yield of a full-grown tree is about 1,000 fruits, weighing from 2—3 lbs. each. The "Fernandin" variety is oval in shape, has a reddish bloom towards the base and possesses the best keeping properties. The garden price is Rs. 2 to Rs. 3 per 100. "Ishad" is round in shape, sweeter and more juicy

than "Fernandin," "Kala" having black and "Ujla" white spots or marks when fully ripe. It fetches Re. 1-8 to Rs. 2 per 100; the others, though larger in size and containing smaller "stones," are inferior in point of flavour. The usual price is from Re. 1 per 100. It is generally held that the later the ripening period the better the mango variety.

Of sour mango varieties, the best are :—

1. "Gaonthi" or "Chalti;" 2. "Appe mavu"; 3. "Jirge mavu;" 4. "Muge mavu"; 5. "Picha mavu."

"Gaonthi" is the most favoured variety being grown in every "compound." The average yield of a full-grown tree is about 1,500 fruits which sell at the rate of annas 12 per 100. "Appe" only grows by the side of "nallas" in the more hilly tracts. "Jirge" is a fine variety, "Muge" coarse, and "Picha" rather "stringy." Large consignments of these sour mangoes are shipped to England for the making of pickles and chutney, as well as being used locally for the same purpose. At Mulki, near Kumta, and Bhatkal in the south, the best specimens of mango and jackfruit are raised. Jackfruit, in fact, grows so prolifically that it is fed to cattle as fodder. The chief varieties are :—1. "Bokke or Barko;" 2. "Chakki," Tilwa" or "Ambli;" 3. "Nirhalsu;" 4. "Berhalsu." The last two are about the size of a full-grown coconut and are exclusively used, when raw, as vegetables. "Berhalsu" is so named from the fruit being borne near the roots. "Chakki" is more juicy, softer, sweeter and more easily digested than "Bokke," but lacks the flavour. The average yield of a full-grown and well-nourished tree is about 50 fruits. "Bokke" and "Chakki" are sold by the gardeners at Rs. 3 per 100; "Nirhalsu" and "Berhalsu" at annas 10 per 100.

As regards coconuts, the finest flavoured ones are grown along the coast, while those at Kodlagadda near Yellapur, above-ghats, are noted for their extremely large size, quantity of "milk" and percentage of oil. The prevailing practice above-ghats is to grow "supari" and coconut palms together and below-ghats plantains and coconuts. The average number of palms per acre in a first class coconut garden is about 200. They

are invariably planted in alternate rows and spaced 12 feet apart to permit of ring irrigation. Black salt-mud from the river mouths is the chief fertiliser used. At Ankola and Kumta, on the coast, a properly tended coconut palm gives a yield of about 50 to 100 nuts a year, while at Kodlagadda the yield is 60 to 120 nuts a year, and the price obtained is respectively Rs. 4 and Rs. 3-8 per 100. The average nett profit from an acre of first class coconut garden both above and below ghats is calculated to be Rs. 200, the extra profit from the increase in yield above-ghats being consumed by the greater expense of hired labour.

At Amdoli and Bellikerri (9 miles from Karwar), the finest cashewnuts are cultivated. There are two varieties: 1. Yellow; 2. Red. The average yield per tree is about 600 fruits, weighing 6 lbs., and worth from 6—8 annas. A sandy soil is best suited to their growth.

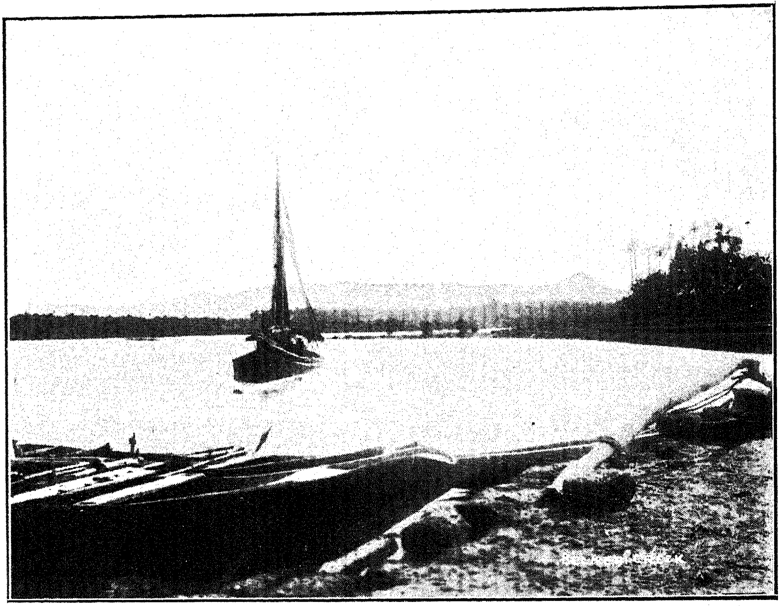
In Yellapur taluka above-ghats (2,000 feet altitude) limes, lemons, oranges and pomelos are extensively grown along with the other less important fruits mentioned in the list above. Sweet oranges are grown in first class gardens only. The "santra" variety is spherical in shape and, though small, weighs about 7 ounces, while the "ladu" weighs about 5 ounces and is recognised by a papilla at the base next the stalk giving the fruit a characteristic balloon-like appearance. The rind of both is moderately smooth, thin and loose, the pulp dark-coloured, exceedingly juicy and of excellent flavour. The prices are usually Re. 1 and annas 8 per 100. The "bigaradia" or sour oranges locally known as "Ili hannu," are largely grown and used in the preparation of chutney. The average yield per tree is about 150 fruits and the wholesale prices realised are annas 8 and annas 6 per 100 according to size. The thin-skinned red pomelos measure 7 inches in diameter, weigh about 4 lbs., and along with mangoes are considered by some the finest fruits in India. The selling price is Rs. 4-8 and Rs. 3 per 100.

Among plantains, the best flavoured are grown along the coast. The chief varieties are: 1. "Rasbale;" 2. "Nirbale;" 3. "Mithabale;" 4. "Karibale;" 5. "Mysorebale;"

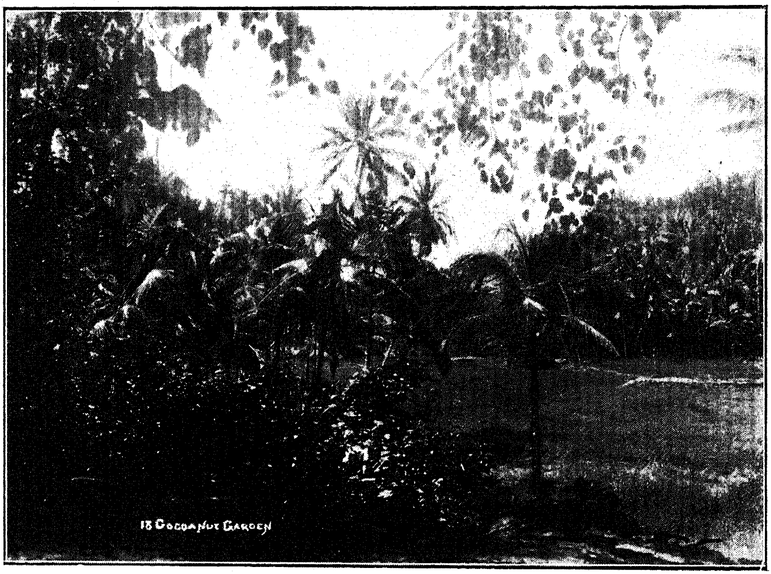
6. "Chandrabale;" and 7. "Anabale." "Rasbale" ranks as best. It is about $4\frac{1}{2}$ inches long, sweet-scented, of fine flavour and very soft and juicy. It is particularly wholesome and fetches at the gardens annas 6 to annas 10 per 100. "Nirbale" and "Mithabale" varieties measure about 3 or 4 inches in length. They are narrow, thin-skinned, very sweet and of excellent flavour. The garden price is annas 4 to annas 6 per 100. "Karibale" or "Saldati" is quite semi-circular in shape with a very thick skin which turns black when fully ripe. Within the pulp is pure white, fine-flavoured and very refreshing to eat, but if indulged in too freely is said to produce fever. Price, annas 5 per 100. "Chandrabale," as its name implies, is red skinned, likewise also "Mysorebale." The former measures from 6—8 inches long and is moderately thick or coarse. The latter variety is about half the size, slightly tart and contains many seeds. The average yield per tree of these two varieties is about 15 or 20 fruits and the price annas 6 and annas 3 per 100 respectively. "Anabale" or "Bhainsi" is the largest of all and measures about 1 foot long. It is thick and coarse, usually allowed to become quite dry by placing in the sun and then used in fruit curry. The selling price is annas 10 per 100. The red or "kagdali" soil is regarded as the best of all for plantain growing. An acre of first class garden land is capable of containing 1,200 shoots. Each shoot bears annually only one bunch called "ghadaya," containing about 100 fruits. The best plantains are cut green and allowed to ripen slowly and uniformly by hanging up in a cool dark place. This practice causes the fruit to remain juicy and soft, possess a fine colour and fetch a better price, besides avoiding destruction by monkeys, squirrels and birds.

The Tamarind, Kumrak and Bilimbi fruits are used in preparing *deshi* chutney, while the remainder, when ripe, find a place in the daily menu of those who can afford luxuries. The annual return from an acre of a first class fruit garden is estimated at Rs. 500 and the expenses of upkeep are put at about Rs. 200, leaving a profit of Rs. 300.

PLATE XLIV.



A. J. I. TYPICAL RIVER SCENE, NORTH KANARA.



ENTRANCE TO A COCOANUT AND SUPARI GARDEN, NORTH KANARA.

Spice Gardens.—In the spice gardens, besides the betel palm "supari" (*Areca catechu*) the spices grown are :—

Pepper (*Piper nigrum Linn.*—vars.).
Pan (*Piper betel Linn.*) grown for leaf only.
Cardamoms (*Elettaria cardamomum*).
Cloves (*Eugenia caryophyllata*).
Nutmeg (*Myristica fragrans*).
Ginger (*Zingiber officinale*).
Cinnamon (*Cinnamomum zeylanicum*).
Chillies (*Capsicum frutescens*).

The cultivation of "supari" is confined to the above-ghat talukas of Siddapur, Sirsi and Yellapur. In laying out a spice garden, the ground is first of all formed into beds 20 ft. wide by trenches which serve as drainage channels. Twelve feet apart and two feet from the edge of the drains, plantain suckers are set. Raised irrigation channels are formed down the middle of each bed and the plantains watered every 15 days during the dry weather. After two years young betel palms are transplanted into pits dug mid-way between the plantains. The plantains not only afford shelter but the returns from disposing of the fruit (about Rs. 25 per acre) cover part of the initial expenditure. After the young palms have become thoroughly established, the plantain shade and catch crop is gradually removed and cardamom bushes substituted. It takes about 13 years for a betel palm to come into full bearing. One acre of first class spice garden land containing about 500 to 800 palms gives an average annual yield of 3 khandis (60 maunds or 15 cwts.) of cleaned nuts. The price of the nuts varies each season according to quality of crop and quantity available. In one khandi (20 maunds or 5 cwts.) 5 grades of nuts are usually distinguished and, if cut at the proper time, the proportion and price is as follows :—

5 maunds	"Api"	@ Rs.	8	per maund	...	Rs.	40
7 ,,	"Chikni"	@ Rs.	5	,,	...	,,	35
6 ,,	"Betti"	@ Rs.	4	,,	...	,,	24
1 ,,	"Gotu"	@ Rs.	2	,,	...	,,	2
1 ,,	"Chali"	@ Rs.	2	,,	...	,,	2
					Total	Rs.	103

One acre, therefore, gives an approximate return of Rs. 310. The pepper "vines" are of three varieties, each differing in yield and manner of growth, but the quality is practically the same in all. The "kari-malisaru" variety, for example, gives the best yield, but will only grow in what is known as "kagdali" soil (a red mould), while the other two "sambar" and "arsina murtiga" will only grow in the khaki soapy (talc) clay soil, called "arsina munnu". The "vines" are trained up the stems of the betel palms. Cardamom seedlings are planted in the intervening spaces—about 300 going to the acre. The same treatment in the way of manures, watering, etc., serves for all. After six years, the "vines" give, on an average, an outturn of 15 to 18 maunds ($3\frac{3}{4}$ to $4\frac{1}{2}$ cwts.) of "pepper-corns" per acre—value, at Rs. 5-8 per maund, Rs. 82-8 and Rs. 99 respectively, and after three years, the cardamoms give a return of 1 maund (28lbs.) per acre—value Rs. 48. What is reckoned the best "pan" (Piper betel) comes from Hosakuli, 3 miles from Kumta. The "Pan" or betel vine thrives best when trained on mango trees. After three years, an acre of garden containing 500 vines gives an outturn of 40,000 leaves per annum, worth about Rs. 40. A complete spice garden in full bearing is calculated to bring in an annual return of at least Rs. 400 per acre, but the expenses of upkeep, harvesting, etc., being exceptionally heavy (Rs. 280—Rs. 300) there is a clear profit of only Rs. 100—120 per acre. These gardens are entirely in the hands of Havig Brahmins—a very intelligent and industrious class of men. The most of the fruits, nuts, and spices are regularly bought by traders and sent to Bombay, Hubli and Dharwar markets. Coconut and other oils are extracted and manufactured chiefly in the towns of Hubli and Dharwar.

Paddy Lands.—The paddy-growing tracts are confined to the below-ghat plain and coast tract and to the above-ghat clearings and open plateau. Paddy is universally grown during the rains, the richer lands yielding a "waingan" or spring crop afterwards. The soil and climatic conditions above- and below-ghats differing considerably, a short description of each might be

interesting as well as explanatory of the methods of sowing, cultivation, etc., adopted, but more especially to show how the continuous influence of a particular environment during an unknown period of time seems to have determined resultant types of paddy best adapted to those conditions.

Below-ghat Soil.—The low-land plain and coast tract extends right along by the seashore for 70 miles and inland about 20 miles to the base of the Sahyadri range. It comprises detached areas of arable land mostly terraced since the ground has a natural slope seawards and the terracing not only checks the flow of water during the rains, but prevents the particles of fertile soil from the hill-sides being washed away. "Bandhs" are erected where necessary to keep out the flood waters of the rivers or the sea at high tide and to regulate the depth of water in each area.

The cultivated soil of these flats consists, for the most part of a reddish alluvial clay, locally known as "betta" and has apparently originated from the laterite or iron claystone (basic lava) of the hills near the coast. If this clay is not constantly worked and heavily dressed with green manure, it stiffens into clods and stifles growth. Adjacent to the forest, as well as at the upper ends of the valleys, the soil differs in texture, being more of the nature of a red mould with a large proportion of vegetable and other organic matter and an abundance of white mica particles—probably derived from the gneiss and micaceous schists which underlie the laterite rock. This particular soil is called "kagdali" and forms the fruit garden soil already referred to.

At the lower ends of the valleys and bordered by the rivers are the so-called "Kar" lands, inundated during the monsoon with brackish water, and after the floods have subsided, a fine rich alluvium is deposited called "bailu" upon which "waingan" or spring paddy is grown under irrigation. Wherever this deposit abuts upon the shore, it becomes overlaid or mixed with drift sand and then receives the name "pullan."

The sandy soil of the coast called "majalu" is naturally poor and much broken up by salt water creeks, but all the same

it is able to produce a crop of paddy and afterwards a crop of first-rate vegetables, if watered from temporary wells dug close by for the purpose. The vegetables include a large number of varieties of Cucumbers, Gourds, Melons, Brinjals, Tomatoes, Sweet Potatoes, Yams, Onions, Garlic, etc., "tatti" houses and frames being erected for growing the first five of these.

In addition, there are at certain coast places, *e.g.*, Kumta, Madangeri, Molki, etc., large areas of reclaimed shore, called "gazini," composed of black mud with varying quantities of salt, decaying oyster shells and other organic matter. The amount of salt present determines the particular variety of salt-paddy that can be grown, but the presence of too much shell-lime is detrimental to the growth of all varieties.

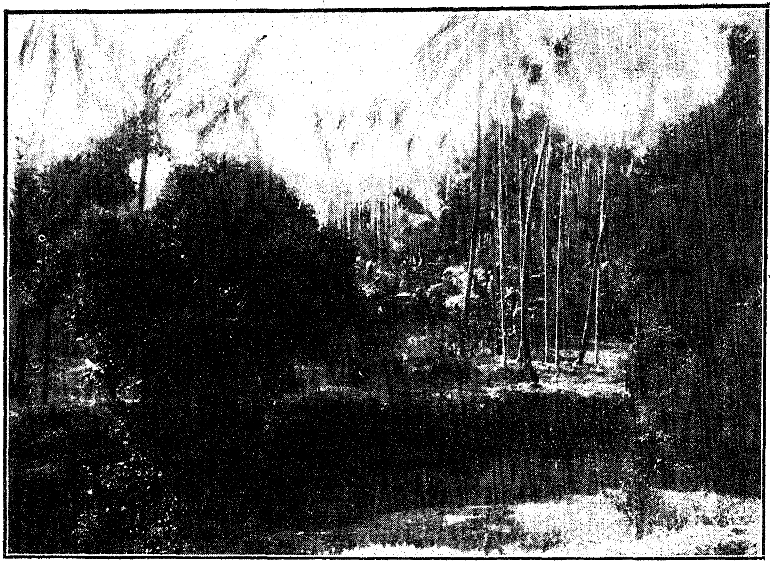
Still another type of soil known as "Makki" is met with, in patches, at varying altitudes. It is stony, coarse and porous, being simply the weathered crust of underlying murum and varies in depth from a few inches. (Compare the soil of the "khushki" or dry-crop land above-ghats.)

Thus, below-ghats there exist seven different types of soil, each and all of which are peculiarly suited to the growth of particular varieties of paddy.

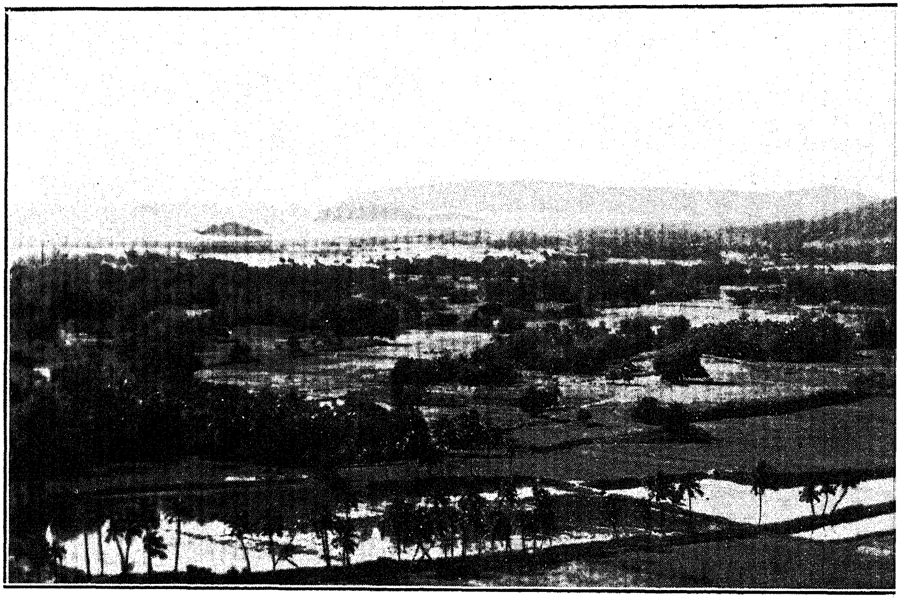
Above-ghat Soil.—Above-ghats, the land, as already mentioned, is a more or less level plateau covered with extensive jungle. In former times the Kunbi tribes burned or cut down portions of the jungle and sowed the land with "ragi" (*Eleusine coracana*) or "bajri" (*Pennisetum typhoideum*)—generally known as "kumri" or "jhum" cultivation. These clearings now form many of the paddy and dry-crop lands. The types of soil range from a khaki-coloured and extremely moist soapy (talc) clay called "arsina munnu" to a ferruginous clay-loam largely mixed with milky quartz and ironstone gravel, shading off gradually into the black cotton soil as the Hubli and Dharwar Districts in the north-east are approached.

The soapy clay, formed from the outcropping talc and micaceous schists, when mixed with liberal supplies of well-rotted leaf-manure and cowdung, forms the soil of the betelnut and spice

PLATE XLV.



A. J. I. TYPICAL SUPARI AND SPICE GARDEN ABOVE GHATS, NORTH KANARA.



TYPICAL BIRD'S-EYE VIEW OF FRUIT GARDENS AND PADDY LANDS BELOW GHATS, NORTH

gardens at Siddapur, Sirsi and Yellapur on the western side, while the richer loam constitutes the soil of the fruit gardens and the basis of that in the lower lying paddy lands, from Siddapur in the south as far north as Mundgod and Yellapur talukas.

The soil proper of these paddy or wet lands called "tari," contains an abundance of decaying vegetable matter, receiving, as it regularly does, the rubbish and silt washed down by the heavy rains from the forest and garden lands above. On the higher levels, notably around Hubli and Dharwar, the "khushki" land in which the dry crops flourish (Millets, Sesamum, Safflower, etc.) is a coarse red gravel containing varying amounts of organic matter, while the soil of Haliyal taluka, in the extreme north, forms a distinct contrast to all the others, being a bluish-green clay derived from the chlorite slate and other transition rocks which form an outstanding feature of the geology of that district.

For irrigation supplies the people are entirely dependent upon a few mountain streams, wells, or underground springs, conducted into huge stone-built tanks. The soil being always moist, however, some of the finer and better varieties of paddy are grown, while, in the spice and fruit gardens, draining has to be carefully attended to during the rains. The paddy lands are terraced wherever the ground slopes, "bandhs" being also formed to retain the monsoon waters and the overflow from garden lands. As the fields, and more especially the orchards, are often ravaged by wild boars and deer from the jungle, high, strong, wooden fences bound together with barbed wire form a barrier all round with sometimes an additional hedge of live thorn bushes, such as Prickly pear (*Opuntia nigricans*), Milk bush (*Euphorbia tirucalli*), Mysore thorn (*Cæsalpinia sepiaria*), etc.

A broad ditch, serving at times as an irrigation or drainage channel, surrounds the whole garden, very often with four or five alternating rows of coconut palms on either side.

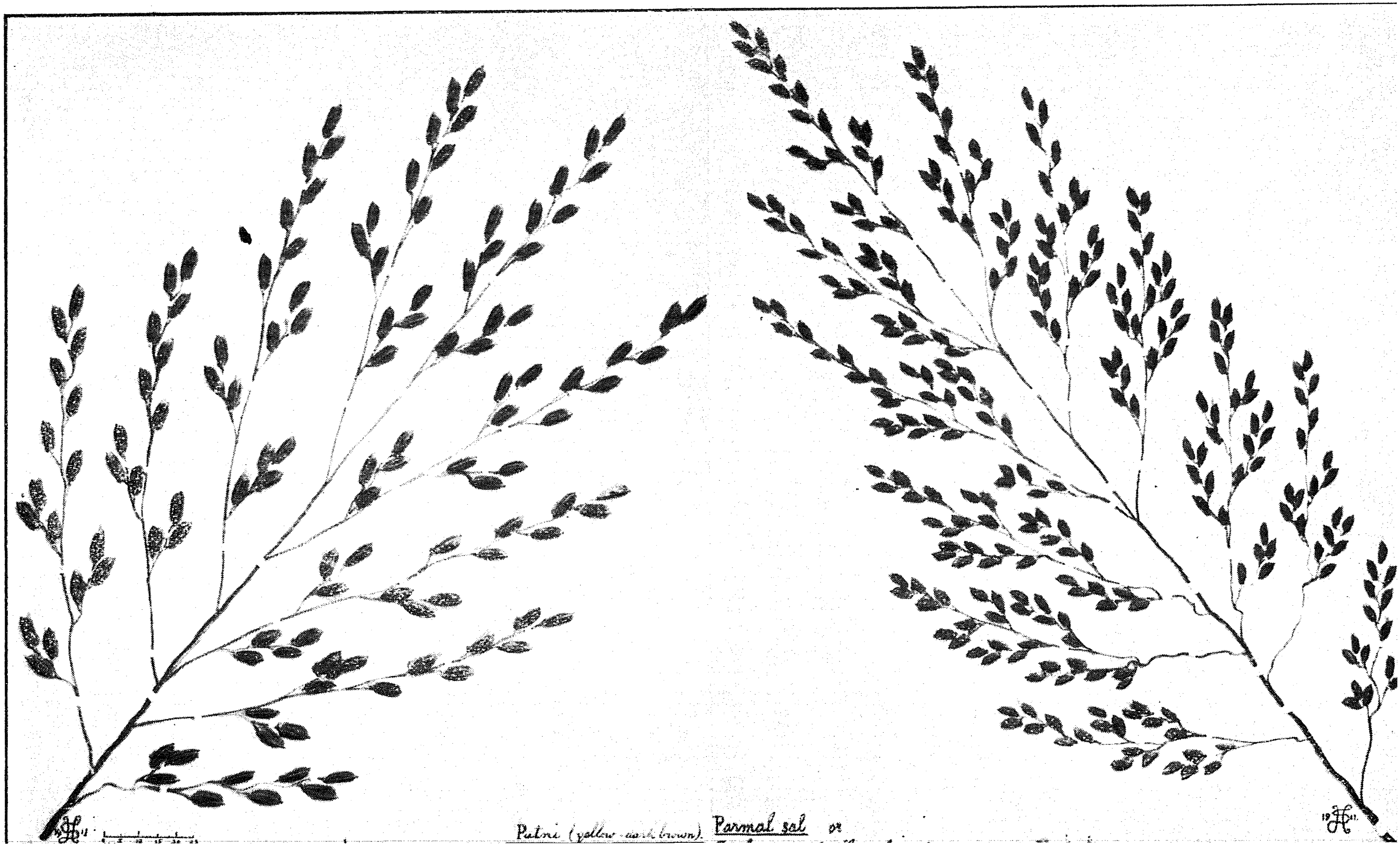
En passant, the village of Ekambi, about ten miles from Sirsi, is named after what is described as "the largest and most

magnificent specimen of wild mango tree in India" to be seen growing on the outskirts of the jungle close by.

Climate.—One of the most notable features in the climate of North Kanara is its equable temperature throughout the year. In the coast plain the temperature varies from 84·3° F. in May to 75·9° F. in January and averages 80·1° F.; while above-ghats it varies from 82·3° F. in April to 72·7° F. in January and averages 76·2° F. The normal humidity below-ghats is 74° and above-ghats 57°. As regards rainfall, the returns show that this is much higher on the coast than in the uplands, and also varies north and south in these divisions. On the north-west coast the average annual rainfall is 116·6 inches and on the south-west 139·85 inches; while in the northern uplands it is 47·8 inches, and in the southern 95·62 inches. Local position has considerable influence—distance from the sea on one hand and from the crest of the Sahyadris on the other are the chief points determining the rainfall. In the coast tracts in June, for example, the clouds are driven against the western slopes of the Sahyadris and the country is flooded. In the uplands, beginning early in May, intermittent showers fall, the clouds being apparently attracted to the wooded heights, while further east they very often float far overhead without breaking.

Paddy Sowing.—Below-ghats paddy is either broadcasted with dry seed ("bere bhatta") or with sprouted seed ("mul bhatta") or else transplanted ("neti bhatta") depending on the nature of the land. The "bailu," "pullan" and "kar" lands are usually transplanted; the "gazini," "majalu" and "betta" lands are sown with germinated seed, while the "makki" lands are broadcasted in the ordinary way. The outturn, quality and consistency of grain follow this same order. The using of germinated grains is economical, in that it saves a quarter of the sowing seed, and ensures a more even as well as an actual crop should the seed have been obtained offhand; moreover, it seems the only possible way of sowing in, or dealing with, the extremely soft, sticky and boglike clay or fertile mud after the rains have set in.

PLATE XLVI.



Putni (yellow dark brown) Parmal sal or

Above-ghats, on the other hand, the paddy is nearly all drilled ("kurige bhatta"), partly owing to the lower and less certain rainfall, but more particularly on account of scarcity and price of hired labour, since most of the farm coolies migrate to the below-ghat villages for the rainy season. Hence it is more profitable to drill the paddy whenever the premonsoon showers break; all that remains to be done during the rains being one or two weedings, generally carried out by the cultivator and his family. The migration of the people is due to the malarious nature of the villages during the latter half of the rains. The proximity of the jungle shuts off air currents and causes the atmosphere to be close, steamy and unwholesome, while the stagnant water forms a favourable breeding ground for the dreaded "anopheles" mosquito. Food stuffs, clothes, etc., are more expensive, having to be brought by road either from the nearest sea-port, Kumta—40 miles off, or the railway at Hubli—a distance of 60 miles.

Paddy Manures.—The question of manures for paddy is a delicate one in Kanara. Below-ghats all the ryots assert that iron clay makes poor soil, and therefore the one and only manure suitable for the growing of paddy is "soppu," *i.e.*, a mixture of green leaves and cowdung. In the olden days, before the Forest Department was in existence, the people used to go to the forests and cut down as much green leaf as they required. This was then spread on the floors of their cattle sheds and, after three or four days, removed and placed in a heap outside. Later it was carried to the fields, spread-over and ploughed-in. The continual and promiscuous cutting of forest trees had to be put a stop to, as valuable timber trees were being ruthlessly destroyed and, what was even worse, whole hill-sides were being denuded, with the not unnatural result that when the heavy rains fell, all the soil was washed away, leaving only bare rock.

The contour and climatic conditions were thus rapidly undergoing a change; hence it necessitated strict rules being enforced by the Forest Department. This procedure naturally created great discontent amongst the ryots, but recently more liberal

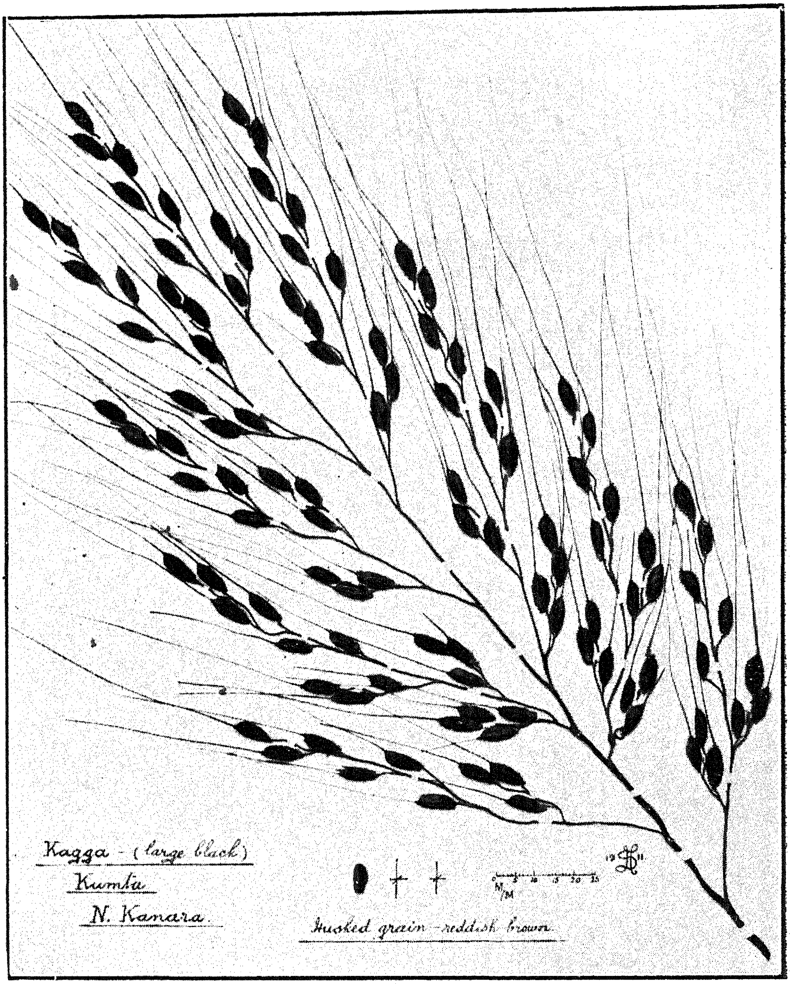
privileges have been conceded to them. If the growing of green manure crops were adopted, the ryots might be to a certain extent independent of the Forest Department.

Above-ghats, the soil, being of a richer and less clayey (*i.e.*, more open) nature, there is not the same necessity for green manuring. Cowdung, dead leaves, paddy-straw, paddy-husk and wood-ashes mixed together are ploughed in, or this same mixture is burned on the ground first of all.

The black cotton soil of Dharwar District is not considered so suitable for paddy cultivation, and the rainfall being somewhat precarious forms a limit in this direction. Tank irrigation is, however, resorted to in certain places. Generally speaking, it may be said that in North Kanara paddy is grown in every type of soil, provided the rainfall is not less than 45 to 50 inches. The number of types of paddy grown, each possessing some characteristic feature, is very large indeed and forms the subject of an investigation at the present time. This short survey, however, makes it obvious that the paddy plant possesses a remarkably ready power of adapting itself to a wide range of environmental conditions when aided, to a greater or less extent, by artificial means. As in most plants, this adaptation is indicated outwardly in a specific manner. The higher and drier land paddies are short and weak stemmed, with coarse, bristly or awned grains, ripening early and giving a varying yield comparable with the respective fertility of the soil. The straw of these varieties makes excellent fodder, being soft, juicy and low in indigestible cellulose content. ("Patni"—Plate XLVI). The low-lying, rich, moist or flooded lands produce the long, thick-stemmed varieties, giving small, scented, smooth, awnless grains, late ripening and high in yields. ("Parmal sal"—Plate XLVI). The salt paddies, on the other hand, are generally long and thick-stemmed, with huge, coarse, awned or awnless grains, giving a high outturn and ripening early; but the taste of the grain is musty and rather unpleasant. ("Kagga"—Plate XLVII).

Yellow, brown, red, black, etc., types of husk (both glumes and pales) occur in all, with either white or red seed-coats

PLATE XLVII.



A. J. I.

(pericarps). As regards etymology of nomenclature, in the majority of cases the characteristic shape, size, colour, habit, taste, etc., of grain ; its similarity to other flowers, seeds, fruits, tubers, etc., in respect of scent, shape, appearance, etc.; association with particular places and soils, as well as personages ; methods of sowing, cultivation, etc., have all given rise to a vocabulary of names which at first sight appears rather bulky, but on investigation proves to be largely composed of synonyms from the various dialects—Marathi, Hindustani, Sanskrit, Kanarese and Tamil. Even two neighbouring villages have different names for the same variety. Any attempt at a practical classification, after pure cultures have been obtained, seems necessarily based upon such like considerations.

Note.—The photographs in Plates XLIV and XLV illustrating this article were kindly supplied by Mr. F. J. Varley, formerly Collector of North Kanara, and Mr. G. Laird MacGregor, Collector of Dharwar.

A SIMPLE HONEY-EXTRACTOR.

By T. BAINBRIGGE FLETCHER, R.N., F.E.S., F.Z.S.,

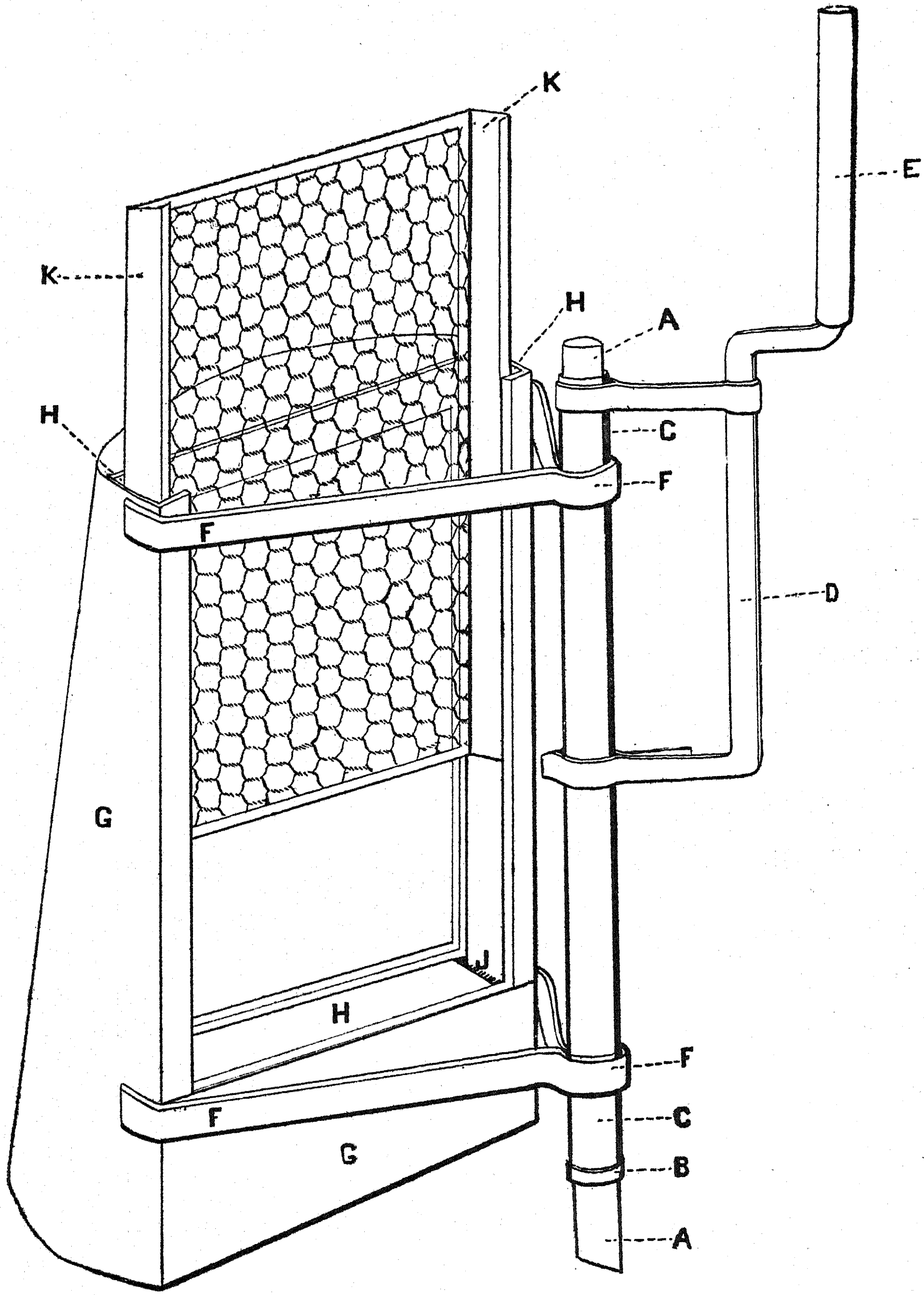
Offg. Imperial Entomologist.

[*Member of the British Bee-Keepers' Association.*]

The recent want of an extractor to remove surplus honey from the bee-hives at Pusa led us to construct, with the help of the Farm blacksmith, a simple machine which proved quite effective, and of which a description is given here as it may prove equally useful to other bee-keepers in India, who own only a small number of hives, though it is unsuitable for a large apiary as only one comb can be operated on at a time. Its construction, for which no originality is claimed, is quite simple and well within the reach of any ordinary skilled blacksmith or mechanic.

Like all similar machines, its action depends on the principle of centrifugal force. We all know that if we tie a weight on to a string and whirl it round there is a perceptible pull on the string, and that, if we suddenly release the string, the weight will fly off at a tangent. This is the principle we employ. By revolving the frame, the honey is thrown out of the cells without damaging the comb, which is afterwards given back to the bees to clean and refill. The honey is in fact thrown out just like water from a trundled mop.

The extractor revolves around a long, round, iron pin or stake (A A), sharp-pointed at the lower end, which is thrust firmly into the ground, and provided with a narrow metal collar (B) on which rests the weight of the moving parts. These are suspended from a hollow iron tube (C), which fits over the central pin A and rests on the collar (B). To one side of (C) is riveted the



A SIMPLE HONEY-EXTRACTOR.
(For explanation of lettering see text.)

handle (D), the top of which is loosely covered with a piece of bamboo (E). To the opposite side of the tube (C) are riveted two iron V-shaped arms (F) which support the honey-can (G). This latter may be made of stout tin-plate—the ordinary kerosene tin of commerce provides suitable material—but *galvanised iron must not be used;* it must of course be closed at the bottom and on the outer side, which is rounded, but the inner side (*i. e.*, the side nearest the tube C) need not be closed above the lower arm of the supporting bracket (F), as shown in the sketch. Inside the honey-can is fitted a wooden framework (H) to receive the cage (K) in which is placed the frame of honeycomb (not shown in the figure). This wooden frame is, of course, open at the top and slotted at each lower angle (J) to take the projecting end of the bar-frame. The cage (K) is made of tin and may be open on one side, as shown in the sketch. The narrow ends slide up and down in the frame (H) and the outer side is made of large-meshed wire-netting; as noted above, galvanized wire-netting must not be used; if nothing better is obtainable, the galvanizing must be burnt off.

The method of use is quite simple. The frame of comb is fitted into the tin cage (K) and the whole slid into the wooden frame (H). The whole process is explained below.

The dimensions of the machine will be governed primarily by the size of the comb-frames, but, to get the best results, the outer surface of the comb should, during extraction, be placed six inches from the centre of the spindle around which it revolves. The standard size of frame, to which all bee-keepers should conform to secure uniformity, is 14 inches long by $8\frac{1}{2}$ inches deep (outside measurements), the top bar being 17 inches long, thus forming a lug at either end for convenience of handling and for suspending the frames in the hives.

Assuming that the combs are full of honey and at least two-thirds sealed over—the longer the honey remains in the hive, the more perfect the ripening—they should be removed and the bees gently shaken or brushed off. It is assumed that the combs to be extracted contain nothing but honey, and that no

brood (immature bees) is contained in them. This end can easily be attained by the use of a sheet of queen-excluding zinc between the brood-chamber (the lowest section of the hive) and the supers in which honey is to be stored.

The honey-cells, being capped over with wax, will require to be opened up, and this is easily done by slicing off the capping with a large flat-bladed knife. Almost any large flat knife may be used, an ordinary breadknife answering admirably. Whatever form of knife is made use of, it must first be dipped in hot water and wiped dry. To uncap, grasp a frame firmly by one end of the top bar, resting the other end on a dish so that the comb is inclined outwards. Then take the warm knife and cut upwards, shaving off the cappings which will fall in the dish. Reverse the comb and uncap the other side in a similar way.

The comb is now ready for extraction and may be slid into the cage which is itself slid into the frame of the machine and the handle turned slowly. Experience will soon show the speed at which the machine should revolve to throw out the honey ; this will vary with the honey itself, but in any case the *minimum* speed necessary is to be used. In the case of new or unwired combs, it is best to extract only about half the honey in the first side, then reverse and extract the whole of the honey in the other side, then again reverse and finish extracting the first side. By proceeding in this way, we avoid some of the pressure exerted by the full cells on the inner surface of the comb upon the empty outer side.

The honey will all collect at the bottom of the can of the extractor, whence it may be poured into any convenient empty vessel. It will contain small particles of wax and other impurities and will therefore lack a proper brightness of appearance. To remedy this, the honey should be strained through a piece of clean cloth or flannel freshly wrung out of hot water ; it will run through very slowly of itself, but by twisting the cloth it may be made to strain through quite rapidly. The honey is now ready to be put away in jars or other receptacles in which it is to be stored.

There are three main rules to be followed when extracting honey. Firstly, never revolve the machine more rapidly than is absolutely necessary, or there is great liability of breaking the combs. Secondly, never extract honey in any place frequented by bees; otherwise, the presence of honey will attract bees and they will start fighting and robbing and causing a disturbance which will be difficult to stop. For the same reason, great care should be taken never to spill honey about anywhere near the hives. Thirdly, do not extract honey from comb containing immature bees, or the brood will be killed and the honey spoilt.

After the honey has been extracted, the empty frames should be given back to the bees to clean up and refill, and the Extractor thoroughly cleaned with hot water and carefully dried.

It is not generally realised what a wasteful practice it is to simply express honey from the comb by squeezing it out from the wax. Wax is a very expensive product for the bees. Experiments have shown that it takes from 10 to 21 lbs. of honey (the quantity varies under different circumstances) to produce 1 lb. of wax and we shall not be far wrong in taking 15 lbs. as an average figure; that is to say, the bees require to consume 15 lbs. weight of honey to make up for the enormous wear and tear of their tissues caused by the secretion of a single pound-weight of wax. The great advantages of an extractor are therefore obvious: not only does it economise honey by preserving for future use all the wax except a thin layer of capping, but it saves the bees a great waste of time in building up new cells—two points which will be found to have a very important bearing on the amount of honey produced by a hive in the year.

A brief summary of what is being done at Pusa in the way of bee-keeping will probably save a great deal of correspondence. We have in India three common kinds of wild honey-bees:—

(i) *Apis dorsata*, a very large species which lives in the hills and the damper regions of the plains, and makes a single

large comb which may measure four or five feet across and which is usually hung under the horizontal branch of a tree or amongst rocks. This bee does not occur at Pusa and we have not experimented with it, but it has the reputation of being very fierce and untameable and its habit of building only a single comb makes it difficult to work with.

(ii) *Apis indica*, a species slightly smaller than the European honey-bee but very similar to it. This builds several parallel combs, generally in a hollow tree, and is kept in a state of semi-cultivation in some places, notably in Assam, boxes being placed for the swarms of wild bees to occupy. This bee has been tried at Pusa, but we have not found it at all satisfactory as it seems quite unable to withstand attacks of wax-moths, which tunnel the combs to such an extent that the bees desert them in disgust.

(iii) *Apis florea*, a very small bee which hangs its small single comb in trees and bushes and on buildings. The honey is excellent, but the whole comb is so small as not to repay cultivation, especially as this bee also suffers badly from wax-moths and is therefore difficult to keep.

In the hills, a variety of the European bee is kept at Simla and other places, but this bee does not do well in the plains—at least, those which were brought to Pusa proved a total failure.

We have been experimenting at Pusa with a new kind of bee which we hope will do well in the plains of India; up to the present it has proved a success, but we shall require a great deal more experience of it under hot weather conditions before we shall feel justified in recommending it to inquirers.

At the present time there is no race of bees which we can recommend to would-be bee-keepers in the plains of India.

Of the native races, *Apis indica* seems to offer the best chance of success, but the bees should be kept in proper frame-hives and this means that everything will have to be done on a scale different from the standard adopted for the English honey-bee; for example, the combs will have to be differently spaced and the foundation and queen-excluders will require to be of different sizes, necessitating special machinery to make them.

In any case, bee-keeping can only be recommended as a supplementary source of income and not as a sole means of livelihood. Anyone who contemplates embarking in this pursuit is strongly recommended to do so on a small scale only; two or three hives are sufficient to start with, and this number may be increased as experience is gained.

THE WAX-MOTH.

By T. BAINBRIGGE FLETCHER, R.N., F.E.S., F.Z.S.,

Officiating Imperial Entomologist.

The Wax-Moth (*Galleria mellonella*) seems to have been originally an inhabitant of the Euro-Asiatic continent and of Africa north of the Sahara, but is now spread by human agency over practically the whole world. If not an original native of North America, it was doubtless taken there with some of the earliest hives of bees imported from Europe. It is said to have been introduced into Australia from Europe before the year 1878, when it was recorded from Queensland, and was first noticed in New Zealand about 1904, having probably been brought in from Australia. In India and Ceylon it is common everywhere, being particularly abundant in the plains of India during the rainy season.

Throughout the whole area of its distribution, the Wax-Moth is looked upon as one of the major enemies of the apiary. In India, in districts where bees are not domesticated, it attacks the combs of the wild honey-bees to such an extent that the bees often desert their nests in disgust and swarm off to found a new one, while it is very rare to find a deserted comb which does not bear traces of the ravages of this pest.

The damage is done wholly by the caterpillar, which tunnels through the bees' combs, lining its galleries with a profuse web of silk. This presents a very characteristic appearance in the later stages of the attack, by which time the comb is often riddled with galleries and almost hidden under a layer of white silky webbing. The wax itself seems to form the sole food of the caterpillar, neither the immature bees nor the honey being eaten by it.

Life-History.

The eggs (Plate XLVIII, fig. 7) are very small, about half a millimetre (one-fiftieth of an inch) in length, with a smooth surface, and are laid by night, being deposited always in the comb, in a more or less concealed situation. They are usually laid in small clusters containing as many as forty eggs, but are sometimes deposited singly. The edges of a brood-comb seem to be preferred for oviposition by the female moth. In the Pusa Insectary broken pieces of honey-comb were supplied to the moths, and they usually laid their eggs in cells along the broken margins; in places where the walls of a cell were pressed down so as to afford a hidden corner, such corners seemed to be preferred to any other situation for oviposition. The moths are rather sluggish in the daytime and may sometimes be seen at rest then on walls, posts, etc.; in the evening they become active and flit about around the bees' combs watching for an opportunity to lay their eggs. The majority of these appear to be laid on the first night after the moth's emergence, and the short life of the moth itself (as shown in the following table) appears worthy of remark.

Details of oviposition of Wax-Moth as recorded in Pusa Insectary.

	Date of Emergence and Pairing.	Eggs.		Male died.	Female died.
		Number laid.	Laid on night of		
1	11th May ...	110	11th May ...	.....	12th May.
2	7th ,, ...	97	8th ,, ...	10th May ...	9th ,,
3	9th ,, ..	*Nil*	....	......	10th ,,
4	10th ,, ...	158	10th May ...	12th May ...	11th ,,
5	11th ,, ...	41	11th ,, ...	12th ,, ...	12th ,,
6	8th ,, ...	30	8th ,, ...	......	11th ,,
7	11th ,, ...	50	11th ,, ...	......	13th ,,
		Nil	12th ,, ...		
8	7th ,, ..	77	8th ,, ...	9th May ...	9th ,,

Details of oviposition of Wax-Moth as recorded in Pusa Insectary—concld.

	Date of Emergence and Pairing.	Eggs.		Male died.	Female died.
		Number laid.	Laid on night of		
9	9th May ...	*Nil*	......	......	10th May.
10	10th ,, ...	76	10th May ...	12th May ...	11th ,,
11	11th ,, ...	4	11th ,, ...	.....	12th ,,
12	7th ,, ...	4	8th ,, ..	9th May ...	9th ,,
13	9th ,, ...	36	9th ,, ...	.....	10th ,,
14	10th ,, ...	6	10th ,, ..	.....	11th ,,
15	11th ,, ...	*Nil*	.....	......	12th ,,
16	10th ,, ...	*Nil*	......	12th May ...	11th ,,
17	11th ,, ...	46	11th May ...	13th ,, ...	12th ,,

The eggs are white when first laid but turn dull and sullied before hatching, and are then exactly concolorous with the wax.

The young caterpillars escape from the egg by biting out a hole of exit; on emergence they do not eat the empty egg-shell, but immediately commence to run about very actively in search of a suitable place to tunnel into the wax of the comb. The caterpillars hatching from a cluster of eggs do not all commence to feed at the same place, but scatter over the comb, each burrowing in separately, the places of their entry being indicated by a mass of small globular fragments of wax. From these points they tunnel into the comb in all directions, feeding on the wax and lining their galleries with a profuse lining of silk in which are entangled minute blackish pellets of frass. In badly infected combs, in which there are many larvæ, the whole surface of the comb is sometimes covered with a mass of this fine webbing and there seems little doubt but that the caterpillars spin these strong silken galleries as a protection to secure themselves from the bees as they advance in their work of destruction.

The young caterpillar on emergence from the egg is about 1 millimetre ($\frac{1}{25}$th inch) long, of a dirty-whitish waxy colour,

with a yellowish head smaller than the prothorax which is the broadest segment of the body; it is slender and grub-like on account of the prominence of the thoracic (true) legs. As noted above, it burrows into the comb, particularly in the septum separating the two layers of cells, and feeds on the wax, eating neither the honey nor the immature bees which may be in the cells. Here it lives and grows until after four or five weeks it becomes full-grown, when it is about 20—25 millimetres ($\frac{4}{5}$th to 1 inch) long, cylindrical, smooth except for a few short hairs, of a dirty white colour, with a red-brown head and a pale-yellow prothoracic shield mottled with brown. (Fig. 2). The grown-up caterpillars are also active, but not nearly so active as the young ones.

When full-fed the caterpillar spins a white silken cocoon either in the comb on which it has been feeding or in some corner or crack of the hive or its surroundings. The cocoon (fig. 3) is closed completely at one end, but the other open end, that towards which the head of the pupa is turned, is left except for a few loose fibres of silk. In many cases the caterpillars all spin up close together, so that the cocoons are fastened together in a solid mass; this is especially the case when a crack or corner is the site selected. The pupa (fig. 4) contained inside the cocoon is from 10 to 15 millimetres ($\frac{2}{5}$ to $\frac{3}{5}$ inch) long, yellow, and with a minutely toothed ridge running along the mid-dorsal region. On the anal extremity are four small cremastral hooks, but these do not appear to be entangled in the fibre of the cocoon as a general rule, though this was of course their original function. The empty pupal shell is left inside the cocoon on the moth's emergence.

The moth itself (figs. 5, 6) is a rather stoutly-built insect, measuring 25 to 40 millimetres (1 to $1\frac{1}{2}$ inches) across the outspread forewings which are of a reddish-brown-grey colour, lighter towards the outer edge; the hindwings are grey-brown. As is usually the case amongst moths, the females are, as a rule, larger than the males and can easily be distinguished by the shape of the outer edge of the forewing, which is straight, whilst in

males it is concave. [Compare figs. 5 (male) and 6 (female).] The moth is not seen about very often in the daytime, but may occasionally be observed at rest on walls, etc., when it sits with its wings folded into a triangle. (Fig. 1.)

The whole life-history of an individual moth covers a period of about six to eight weeks from egg to adult. The following table shows the life-history of some of the moths reared in the Pusa Insectary :—

Life-cycles of Wax-Moths in Pusa Insectary.

	Eggs laid on night of	Larva hatched.	Larva pupated.	Moth emerged.	Life-cycle in days.
1.	8th May ...	15th May ...	28th June...	6th July ...	59
2.	9th ,, ...	16th ,, ...	17th ,, ..	25th June ...	47*
3.	9th ,,	16th ,, ...	2nd July...	10th July ...	62†
4.	10th ,, ...	17th ,, ...	15th June...	23rd June ...	44*
5.	10th ,, ...	17th ,, ...	5th July ...	13th July ...	64†
6.	11th ,, ..	18th ,, .	20th June...	29th June ...	49*
7.	11th ,, ..	18th ,, ...	5th July ..	13th July ...	63†
8.	29th March ...	5th April...	3rd May ..	11th May ...	43

* Shortest and † longest cycles of same broods.

REMEDIES.

Practically nothing can be done to exterminate the moth in India owing to the colonies of wild bees, some kinds of which occur almost everywhere and provide the moth with suitable food. In the case also of bees kept in a more or less domesticated condition in walls of houses, earthenware vessels and ordinary box-hives, little can be done without practically destroying the whole comb, as it is not possible to examine the nest properly and check the damage before it has assumed unduly large proportions. In these cases it is, of course, impossible to fumigate the combs to kill the caterpillars without destroying the bees as well.

The universal prevalence of this destructive moth is one of the strongest arguments for the use of modern forms of beehives in India. The use of a bar-frame hive, in which every comb can be taken out and examined carefully, should be an absolute guarantee against any extensive damage by this pest. The golden rule of Bee-keeping, "keep every colony strong," if

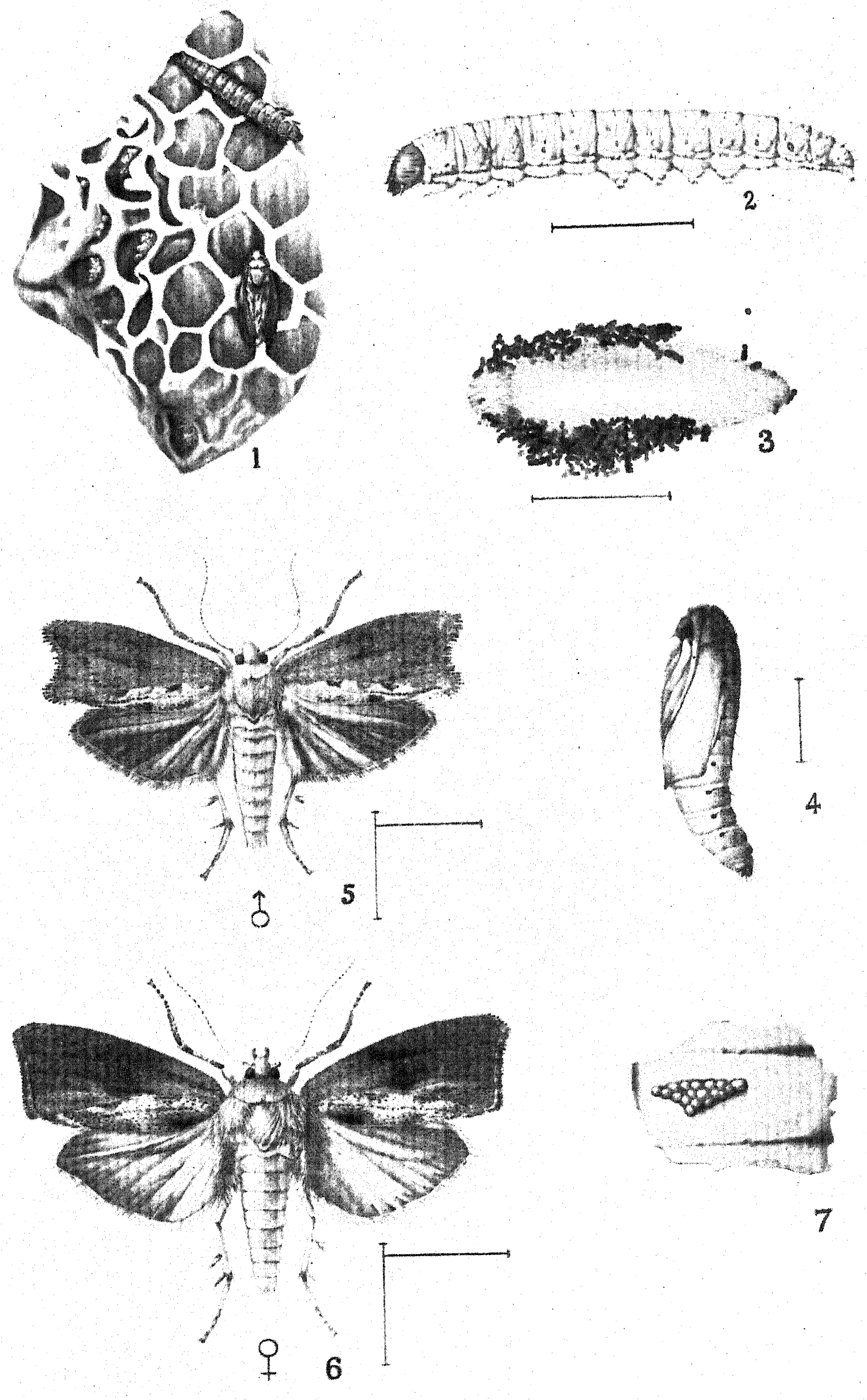
carried out, will do much to mitigate the pest, for the bees themselves will generally keep the moths from the combs if their numbers are sufficient to cover all the frames; Italian bees in particular keep guard against the Wax-Moth, though the native Indian bees are apparently less vigilant. No cracks or chinks of any sort should be allowed in the hive; all such should be filled up with putty or clay. Never leave old combs or pieces of wax lying about, as such are sure to be attacked by the Wax-Moth; they should be put away in tight boxes with a little naphthaline, which can easily be evaporated off again when they are wanted for use.

Explanation of Plate.

Wax-Moth (*Galleria mellonella, Linn.*)

Fig. 1. Piece of comb, showing Eggs, Caterpillar and Moth in resting position. Natural size.
,, 2. Caterpillar (full-grown).
,, 3. Cocoon.
,, 4. Pupa.
,, 5. Male moth.
,, 6. Female moth.
,, 7. Cluster of Eggs (greatly magnified).

(The natural sizes of figures 2—6 are indicated by the hair-lines shown alongside each.)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MANGO CULTIVATION.

By D. L. NARAYAN RAO,

Proprietor, Nursery Gardens, Hyderabad (Deccan).

THE mango is pre-eminently the fruit of India and rich and poor anxiously wait for the advent of the mango season. In gardens it is given the foremost place and its absence in any garden is a matter for regret. There are no records available as to the actual area under mango cultivation in India. This is probably due to the difficulty of securing even approximately correct information regarding the innumerable varieties scattered all over the land. The total area is undoubtedly large.

The cultivation of mangoes is not equally remunerative everywhere. In Northern India where the tree is common, good mango fruit sells at 20 seers or more per rupee, and in Hyderabad good local fruit is never sold at more than 8 seers for the rupee—the average being only 4 seers. Though Hyderabad possesses extensive gardens in and around it, yet the local supply which is available in May and June is always insufficient to meet the demand. Out of season and early in season Hyderabad gets its supply of this fruit from other parts.

The consignments of mangoes from the East Coast, Poona, Bangalore, Chittoor, Salem and other places compete fairly with the local supply even after paying railway freights for long distances.

Many people in the Deccan and other places complain that mango gardens are run at a loss. Others are planting large areas with it as a safe investment in the belief that they must pay. Some of the large mango gardens were planted by rich men when the economic conditions of the country were different from

what they are now, with the special object of getting as many good varieties of fruit as possible for personal requirements, while profit was only a secondary object. Other gardens planted partly for personal needs and partly with commercial motives are only imitations of the above with regard to principles of gardening. In them very little care is taken with respect to selection either of soils or of varieties of mango.

The idea that mangoes grow equally well in shallow and in deep fertile soils is not based on a careful observation of facts. All successful mango gardens are situated in soils which have at least a depth of 5 feet with good drainage and moisture underground. Hence the fact remains that the best yielders and longest lived and healthiest trees are found in deep fertile retentive soils. In places like the districts of North Arcot, Salem, Bangalore, Bunganpally and the vicinity of Waltair, etc., where the successful cultivation of mangoes has become traditional, the garden owners possess much practical knowledge on the subject. In these districts, varieties eminently fitted for commercial purposes were selected long ago and grown extensively with the result that these districts have been able to supply mangoes every year to distant markets up to the end of August or even later. (1) Dilpasand, (2) Thoothapari, (3) Neelam, (4) Kalapahad, (5) Nawab Pasand (Roomani) at Arcot, (6) Benishan, and (7) Shakerpara at Bunganpally in the Kurnool district are the chief commercial varieties. These varieties have spread to almost all places in Southern India and the Deccan and are easily recognised by gardeners.

The illustration given under the name of Thoothapari at the end of Professor Woodrow's book "The Mango" belongs to the real Dilpasand and not to Thoothapari.

SURE-BEARING.

The mango tree, even when grown in a suitable soil and climate, is a very uncertain bearer and it is very difficult to forecast whether the crop will be good or bad. The hundreds of varieties advertised by nurserymen might be mangoes of

PLATE XLIX.

A. J. I. "DILPASAND" MANGO TREE, SIX YEARS OLD.

very good quality, but a majority of them and a very large majority of seedling mango trees in the country are very unreliable with regard to fruit-bearing. Some of them do not even blossom once in two or three years, but the commercial varieties mentioned can be relied upon to give at least partial crops every year. If half the number of existing trees were to bear fruit every year, the local markets would be glutted and people would be compelled to find new methods of exporting surplus fruit to foreign countries.

The habit of mangoes in producing fruit varies with soil and climate. The Peterpasand of Madras is the same as the Pairi of Bombay or the Goabunder of Hyderabad or the Badami of Chittoor. Being a very rapid grower, this tree is extensively cultivated in all those places and its fruit comes very early to the market, but it is a shy bearer here.

The well-known Alphonso of Bombay, known in Madras as Kaderpasand, and its type the Russapuri of Bangalore is also a very shy bearer. The famous local Mulgoba also is a very shy bearer, but it is said to bear better at Chittoor and Bangalore. The commercial varieties mentioned above, in addition to other virtues seem to bear well in poor soils also.

Some of the best keeping varieties of mango of these parts seem to have originated in Arcot and Salem districts. Some of them keep for two months after removal from the trees. The Benishan is a speciality to Bunganpally and is probably the best mango in the Deccan.

Late-Bearing.

The majority of mango trees mature their fruit in Hyderabad in May-June. Markets then get glutted and prices suddenly fall. In many places the mango season lasts less than three months. By careful attention to late-bearing and long-keeping varieties the season can be extended from three to five months as is the case in Arcot and Salem districts. The fertile tract of country near Waltair in the Vizagapatam district is rapidly becoming a large centre of mango cultivation. The garden

owners there understand their business well. Some of their select varieties are Rajmanu, Nalla Kayala Yandrus, Koram Gova, Swantam and Suverna Rekha, etc. Some of these are probably local names given to foreign plants. Similarly, by searching in other parts of India, suitable commercial varieties can be found. The time of appearance of mango blossom and fruit varies considerably in different parts of India. This has to be definitely ascertained and kept in mind by fruit growers for their own advantage. Here in Hyderabad the mango trees commence to blossom by the 15th December. The majority of trees are in full blossom by the 15th of February.

The greatest enemies to mango blossom appear to be the innumerable small insects known as Aphides which cause what is popularly known as "Mango Honey." People think that this is caused by heavy dew. These Aphides weaken the tree at the time of blossom by sucking its sap and excrete a sort of thick viscid substance which coats the flowers and other parts of the tree like varnish making not only further fertilisation impossible but scorching much of the previously fertilised fruit. A heavy rain is supposed to cleanse the trees and in the absence of it syringing with pure water or soap suds and one per cent. of kerosene oil seems to destroy them. Spraying the trees once or twice with a weak solution of Bordeaux Mixture or Iron Sulphate previous to appearance of the blossom will be found to prove a good precaution against Aphides or other pests which infest these trees.

In America, spraying has become an essential part of gardening, but here it is unknown to cultivators. Its usefulness, importance and advantages can well be illustrated in the case of the mango tree.

Climate.—People in all parts of India are more or less partial in praising the excellence of mango fruit produced in their own locality. There is some truth in the belief among some of the best connoisseurs of mangoes in Hyderabad that even select varieties of grafted mango plants imported from distant places and cultivated here produce better flavoured fruit than the original.

An examination of fruits collected and brought from different parts of India and placed side by side reveals the fact that the fruit of one place differs from that of others in colour, general appearance, smell and other qualities. It is quite possible that the dry Deccan climate with a small average rainfall, although unfavourable to great productiveness of fruit, yet cleanses it of its resinous matters and consequently improves the flavour.

Irrigation.—Much useful information might be collected on the subject of irrigating mango gardens in different soils. The fruit produced from areas which are frequently inundated for irrigation with tank or river water or which have a high underground water-level rising almost to the roots is always inferior to that produced in gardens situated on well-drained slopes and carefully irrigated. During the vigorous period of the growth of mango plants, say up to at least their eighth or tenth year, the trees should be abundantly irrigated so that they may not receive a serious check to their growth. Of course, there are exceptional soils with a high underground water-level on which mango plants do not require any irrigation after the fourth or fifth year from planting.

When fruit is our aim, particularly from well-grown trees, the whole ground under the trees should be well dug with a pick-axe and exposed in October-November after the rains are over. This operation induces the trees to blossom. The ground should remain in this state for about forty days from the time of flowering. It is very often found that if the ground under trees is copiously irrigated just when fruits are setting or when they are only about the size of marbles, the whole crop suddenly withers and drops down onaccount of the sudden rush of sap to them.

Manuring.—Manuring of mango trees with well-rotted litter in July or August once in two or three years increases the yield of fruit, but it is said that high manuring interferes to some extent with the quality. Leaf mould is always the safest manure for mango trees.

Applications of strong manures to unirrigated trees after the rains sometimes even kill them in shallow Morrum soil.

THE NARKANDA PATENT POTATO MEAL FACTORY.

By Colonel R. H. F. RENNICK.

It may interest some of the readers of the Journal to know how the "Patent Potato Meal Industry" recently (that is about two years ago) started at Narkanda in the Simla Hill District originated. About seven years ago, when Sir Edwin Collen was Military Member of Council, the question arose of providing for the British Troops for mobilisation a suitable vegetable ration which could be procured in India in time of war when communication with Europe would be interrupted. The "Mobilisation Scheme" provided the British Troops with a reserve of "Sliced desiccated potatoes" imported from England, which was turned over every two years to accustom the British soldier to its use and taste. Somehow he did not fancy them. They were hard to negotiate, much harder to digest; hours of anxious boiling and grumbling did not give him a decent meal. He loathed their issue and threw them away on service as in Tibet and elsewhere. Apart from their insipid taste, their keeping qualities were uncertain. The tins used to get mildewed and full of weevil, and large stocks had to be repeatedly condemned and replaced from England. The recalcitrant behaviour of the tuber was a source of great anxiety to Sir Edwin Collen and set him to seek a substitute which would commend itself more to the appreciative palate of the men. He then wrote and asked me, as I had already supplied several thousand pounds of apple rings for troops on service, if I could help him to solve this knotty problem. After prolonged and careful experiments with the most desirable and well-known Indian vegetables, I submitted to

him in 1905 samples which were distributed for report to the Quarter-Master-General of the Army and Principal Medical Officer of British Troops in India. The Indian vegetables were not appreciated; but the "potato meal" was favourably reported upon and noted for further experiments. On this, in November 1906, 600lbs. of the potato meal were offered to the Quarter-Master-General free on rail at Kalka for further experimental purposes. These fresh trials being likewise satisfactory, an order for a supply of 28,000lbs. was placed with me in September 1907. On this I at once patented the meal in England and shifted my field of operations from the Kulu Valley to the Kumarsen district which is nearly the centre of the potato-growing country in the Simla Hills, the export trade of which in potatoes alone averages yearly 120,000 maunds and where are large reserves of forests with suitable trees for fuel. I acquired a suitable site about a couple of hundred yards to the north of the Narkanda bungalow, well known to visitors of Simla, installed 3 cauldrons and furnaces for boiling and drying purposes, with a hand-driven kibbling machine. The furnaces not being patented have been made at five different places in India to keep their construction secret. Each is capable of drying 800lbs. to 1,000lbs. of potatoes daily The kibbling was done by a hand-driven machine, and the grinding by the numerous water mills around Narkanda. The tins and the cases for them were locally made but not very satisfactorily as the hill men cannot saw planks to uniform thickness. Thus, this order was met all on a venturesome speculation. When the Quarter-Master-General last year placed an order for over 106,000lbs. of meal, which means putting 5 to 6 hundred thousand pounds of potatoes through the patent process, I did not hesitate; anxious as I was to promote the well-being of the army, I at once extended my requirements to put this order through, and to make the speculative factory a permanent one, self-supporting in every respect. I imported a 5-horse power Campbell Oil Engine to drive the new kibbling and grinding machines which are capable of turning out 80 maunds or some 6,400lbs. of meal a day. The peeling and the slicing are

entirely done by numerous hand machines. On an average 80 hands are employed daily to keep furnaces going. Ten skilled stokers, who have been properly trained to do the work, are employed, for everything depends on the successful roasting of the sliced potatoes to turn out a satisfactory meal. The tuber can only be satisfactorily mealed when it is in prime condition; no sooner does it begin to "sag" or get soft or to germinate than it is utterly useless for mealing purposes.

The chemical analysis of this meal by Messrs. Treacher & Co. of Bombay, and the Chemist of the Chamber of Commerce in Paris is as follows :—

	Per cent.
Salts	6
Fat	0·4
Carbo Hydrates	84·1
Proteids	9·5
Water :	slight moisture.

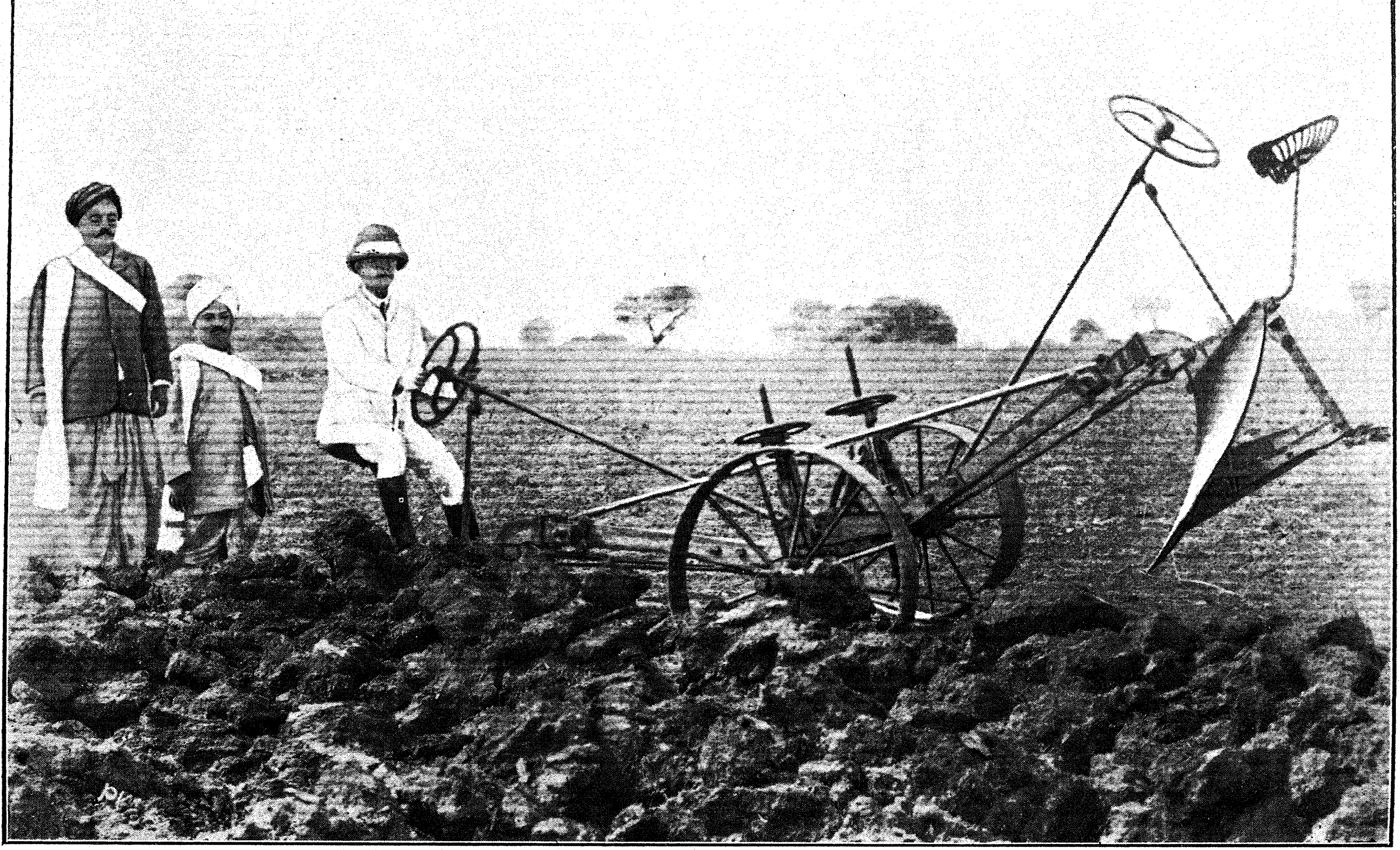
The analysis of the salts made separately shows that the meal contains $2\frac{1}{2}$ per cent. of potash salts together with traces of iron and ammonia salts which are a valuable asset in its favour as an "anti-scorbutic." This verdict or opinion of the analysts is contested by the Military Surgeons who maintain that "desiccation" destroys this property. However this may be, Mr. Calvert and his party on his mission to Tibet four years ago and Mr. David Fraser on his Central Asian journey and their followers who lived entirely on Rennick's patent potato meal, were free from scurvy. I have presented Captain Scott of the Antartic Polar Expedition with 500 free rations to be reported upon as to their anti-scorbutic properties. Unlike the prohibition in force at most factories on the Continent of Europe, in France, Germany and Hungary where it is almost impossible to obtain admission either to a flour mill or gun factory, visitors to Narkanda are welcomed by the owner of the factory who takes great pleasure in showing them over his installation. The venture promises to be a success, for the factory is installed in an "ideal locality" for the development of the industry. Numerous private orders are received

daily which are met with diffidence for fear of falling short of the quantity booked by the Quarter-Master-General.

One firm was anxious to place orders of 10 *tons at a time* which have been gratefully declined until "Tommy Atkins" has been provided for.

NOTES.

Cattle Insurance.—Cattle form a large and valuable portion of a farmer's stock-in-trade. With a view, therefore, to compensate themselves for the loss they sustain from the death of their cattle through contagious diseases, accidents and the like, farmers in many European countries have formed themselves into mutual cattle insurance societies. As the risk of mortality of cattle largely depends upon the owner himself, an organisation formed of the cattle-owners of the neighbourhood or of the same district has been found to exercise an effective control over its members as regards the manner in which the animals are kept, and at the same time to be economically administered, with the result that the premiums to be paid come to a very small sum. The one principle which has been found essential to success is that no compensation should ever be paid for animals dying from ill-treatment on the part of the owner. This makes the owner careful in tending his animals. In some societies a premium is charged on each head of cattle insured, in others it is not fixed but is the result of the apportionment among the members of the total amount of compensation to be paid by the society. But the latter method has this disadvantage that the insured does not know beforehand the cost of his insurance which may vary considerably from year to year. Full compensation is not generally paid, but only three-fourths of the value, to stimulate the diligence of the owner in the protection and good treatment of his animals. In Germany every important illness of the insured animal must be reported to the insurer who in some cases provides gratuitous veterinary assistance. Societies have found it more convenient to insure groups of animals, as individualisation for payment of compensation is difficult and



A. J. I.

Showing Balance Plough and Field ploughed to a Depth of 16 Inches.

easily admits of fraud. The compensation is usually equal to the mean value of the animals.

In India owing to the increasing prices of draught and milch cattle, the want of a means of insuring the farmers against the losses of their cattle is becoming every day more apparent. The Village Co-operative Credit Societies which are being rapidly multiplied, and are bringing home to cultivators the manifold advantages of co-operation, are very like the small mutual insurance societies obtaining in Europe. They could add very much to their usefulness if they took up this important line of work.—(EDITOR.)

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DEEP-PLOUGHING.—The difficulty of ploughing deep by means of direct traction is well known. It has been estimated that in some soils in Europe it requires 14 horses to plough 1 ft. 7 in. deep with direct traction, and that beyond this number of horses practically no advantage can be gained by adding further horses to the team, on account of the loss of power which must of necessity result when the team is increased. This difficulty is severely felt in some tracts of the Bombay Presidency where the cultivators habitually plough about 10 inches deep with the heavy wooden plough, and use up to 5 and 6 pair of oxen to do so. The same difficulty is found in many places by sugar-cane cultivators who wish to plough 1 ft. deep. The introduction of various patterns of turn-wrest plough has done much to solve the difficulty; but it has been found that there are some stiff black soils which are very difficult to plough in the hot weather, and that for eradicating *hariali* grass (*cynodon dactylon*) from deep black soils it is necessary to go deeper than a foot. The difficulty is greatly increased by the size of the clods of earth which are turned up by the plough; and which are so large and stiff that it is almost impossible for the cattle to walk over them. In order to tackle this problem the question of steam ploughing had been considered, but the difficulty of finding the funds (Rs. 40,000) for the trial was too great. It was, therefore, decided to try a large balance plough with two gearings, and the plough

and gearings, as shown in the pictures, were ordered from A. Bajac, Liancourt (Oise), France. The cost was as follows :—

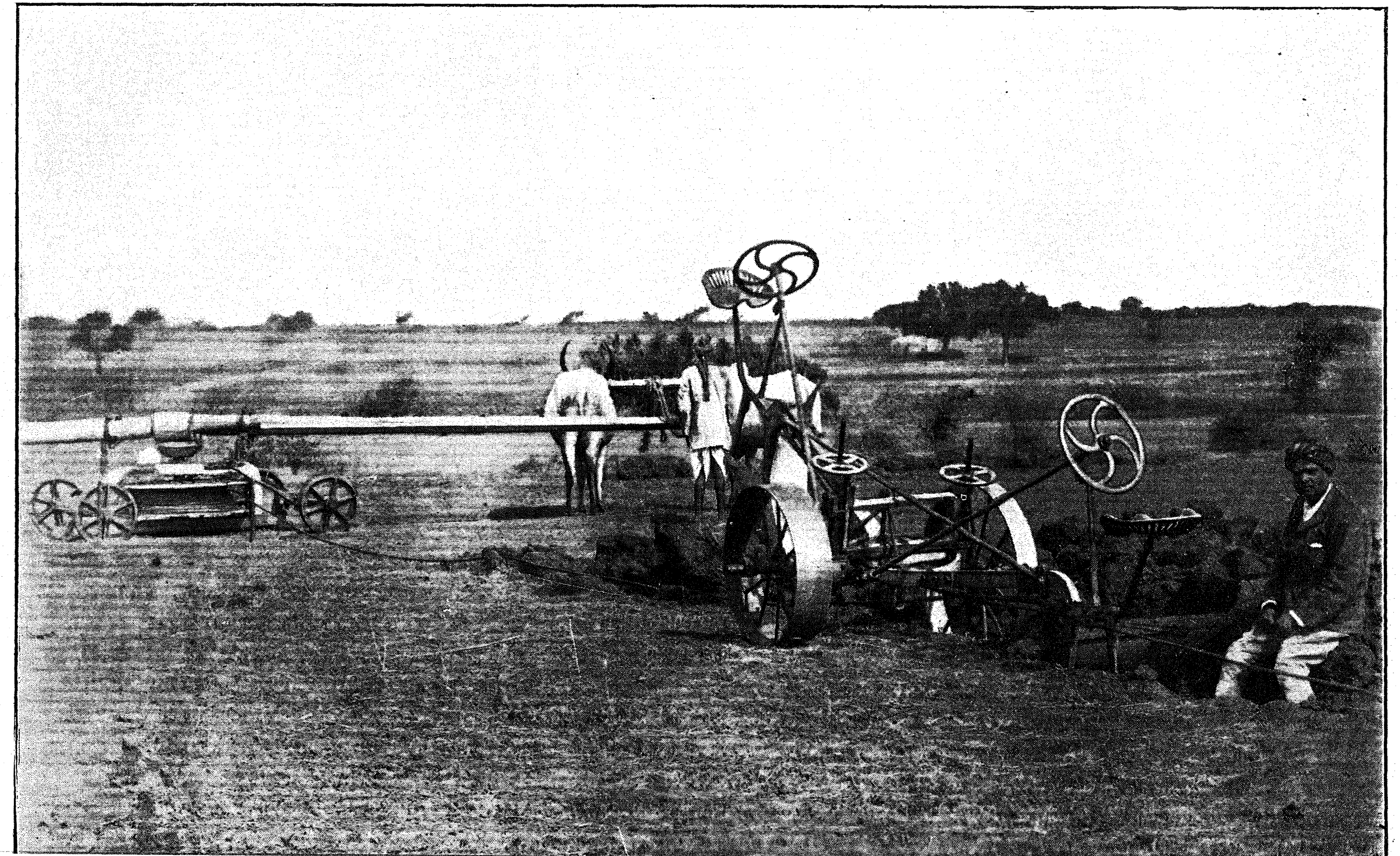
	Rs.
Two gearings with all accessories	1,875
Two small jack screws	62
One (breaking up) balance plough (weight 636 kilos) ...	596
Painting, packing, etc.	238
Freight to Bombay	329
TOTAL Rs. ...	3,100

The plough has been in use for two months in the black soil area in the south of the Bombay Presidency. It has two cables, each 230 yds. in length joining it to the gearings; so the gearings can be fixed up about 220 yds. apart, and the plough works slowly from one to the other opening a furrow 16 in. deep and 16 in. broad. It does very good work, and affords an excellent means of dealing with black soil infested with deep-rooted grasses. It offers an easy load with one pair of good bullocks on each gearing. The only thing against it is that it works very slowly. It ploughs 11 gunthas in 9 hours. This, of course, means a short day for the cattle since each pair will only be working for $4\frac{1}{2}$ hours; and the working day might easily be extended so that one-third of an acre could be ploughed in the day. The possibility of working a two gang plough in this way will also be considered. Meantime the plough has met with the warm approval of large cultivators in the Dharwar District, and many are desirous to hire the tackle at the rate of Rs. 3 a day and to work it with their own cattle and labourers. It is at present being hired out at Rs. 100 a month with a man to look after it.

Taking these rates, and the 9-hour day as a working basis, the net advantage to be gained by using this plough works out as follows. It will plough 11 acres in 40 days.

Hire of plough for 40 days at Rs. 3 a day	Rs.	120
Wages of one man and two boys for 40 days at Re. 1 a day ...	„	40
Hire of 4 bullocks for 40 days at Rs. 2 a day	„	80
TOTAL ...	Rs.	240
Cost per acre ...	Rs.	22 (about)

PLATE LI.



The rates given above have purposely been pitched high, and the figure per acre is an outside one. If the plough is worked for six months in the year and Rs. 3 a day charged, it will bring in Rs. 540 a year, or about 17½ per cent. on outlay, which will allow amply for interest, depreciation and repairs.

As against Rs. 22 per acre for cleaning land by the plough the cost for hand digging is Rs. 40 per acre; and hand digging does not go so deep as the plough.—(G. F. KEATINGE.)

***

RECLAMATION OF LAND BY DEPOSITION OF SILT.—We have been favoured with a copy of a recent inspection note by Mr. G. W. Disney, Sanitary Engineer to the Government of Eastern Bengal and Assam, on silting work at Berhampur (Bengal) and Multrapur (Maldah District) which, in view of the importance of the subject, we reproduce *in toto*.

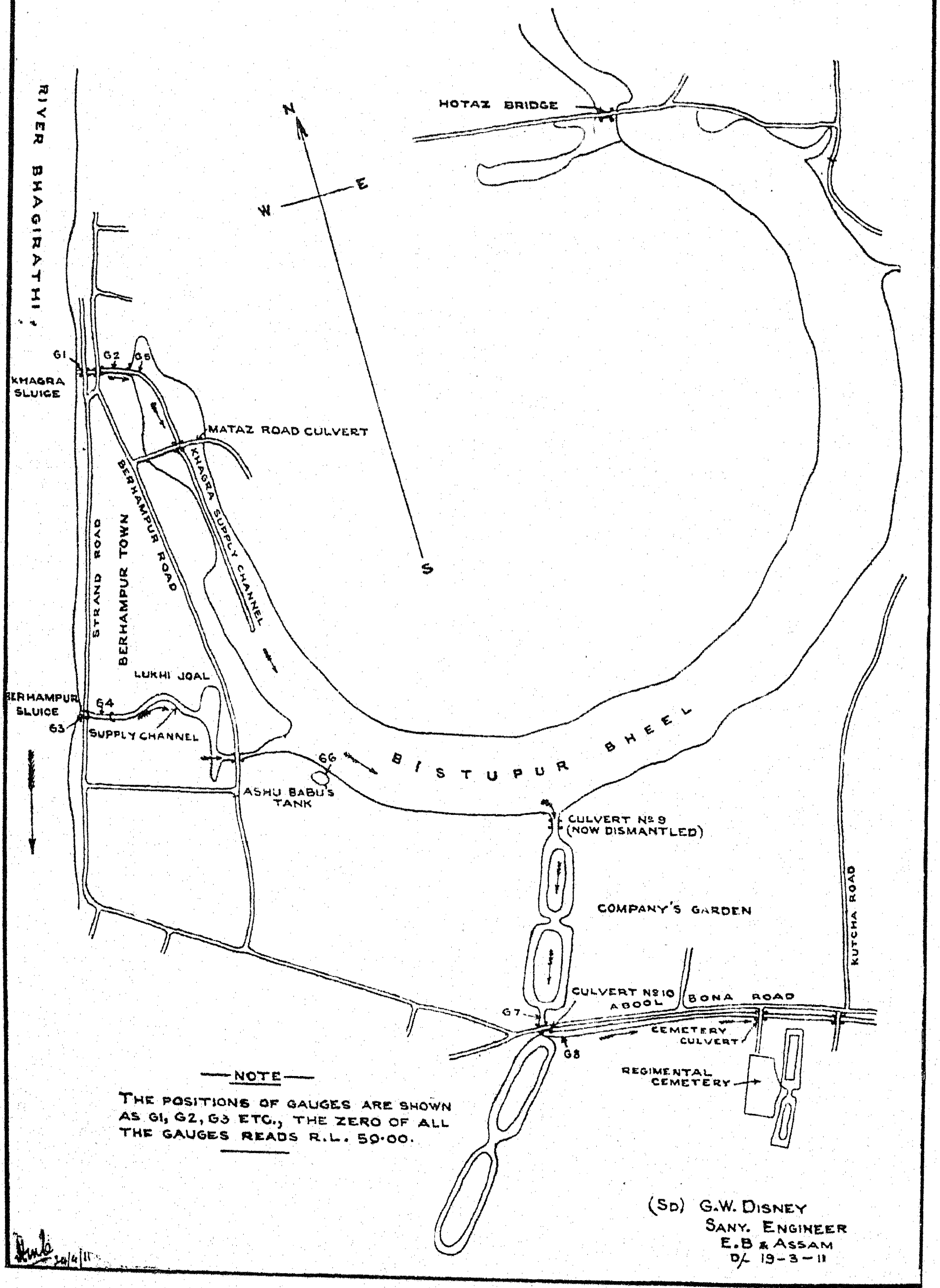
"I inspected the silting operations at the Bistupur Bhil close to Berhampore on the 9th March accompanied by Mr. C. W. Sibold, Executive Engineer, Nadia Rivers Division, who is in immediate charge of the work, and those in the Multrapur Estate carried out by Mr. G. Hennessy, on the 11th both of whom were good enough to give me all available assistance and information.

"2. The Bistupur Bhil is of horse-shoe shape (see plan attached), lying to the North-East of the station of Berhampur. The inception of the scheme was due to a recommendation of the Bengal Drainage Committee that this bhil, to which is assigned an area of two square miles, should be drained. On surveys being made the estimated cost worked out to a prohibitive amount. Attention was then directed to natural accretion by silt deposit, and local conditions in the shape of existing sluices and escapes being available, merely requiring adaptation and remodelling, the necessary expenditure was comparatively small (some Rs. 12,000), and was sanctioned.

"3. The system adopted is that of the current flowing in one direction, the deposition of silt being due to the diminution of the velocity of the current as the water spreads out in the

INDEX PLAN
OF
BISTUPUR BHEEL

SCALE - 1"=1500"



bhil. This effect is aided by the growth of aquatic plants—which further assist in checking the velocity. The mean velocity in the Bhagirathi river, as given by Mr. Buckley, is 2·8 feet per second, and the quantity of dry silt by weight in the water at this velocity as $\frac{1}{1,100}$ (damp silt contains 57 per cent. of dry silt and 43 per cent. of water and 1 cubic foot of dry silt weighs 78 lbs.). As a volume of only some 200 cubic feet per second is admitted by the sluices, there has not to be much spread out in area to reduce the velocity to a silt-depositing one. The flood period has been approximately noted at 90 days during which time silting action will go on. The bhil is fed through two sluices, the Khagra, or upper one, with its floor at a low level, and the Berhampore one at a higher level. This enables the flood water to be admitted when the afflux at the Khagra sluice would render it dangerous to keep the shutters open. The discharge culvert at the southern outlet is capable of discharging 200 cubic feet per second. In July 1910, the maximum quantity of water entering the bhil with both sluices open was 241·25 cusecs, and the discharge 137·69 cusecs. The quantity of silt it is calculated will be required to fill up the bhil is 125 lakhs, and the rate of deposit 8 lakhs per year. The time this will take is therefore 16 years. In 1909 the silt deposit as calculated from cross sections of the bhil was 3, and in 1910, 8 lakhs; in the former season the works were not fully completed. The silting up has therefore cost on the capital expenditure, omitting maintenance charges which so far have been small, at the rate of Rs. 10·9, say Rs. 11, per thousand cubic feet, and for the required amount of 125 lakhs on the same calculation the cost will be about Re. 1 per thousand cubic feet. Even if this figure be trebled, the result would be good.

"4. Mr. Hennessy's work at Multrapur has been based on the flood and ebb system, as compared with that of 'the straight flow through' one adopted at Berhampore. This may be called the open, mouth system. He informs me he has been working this for the last 15 years, and has reclaimed many hundred bighas of bhil land which formerly was valueless, but now

commands a high rental. The class of land he showed me and the crops growing on it could not be surpassed. His system merely consists of an open channel leading to the Ganges from an enclosed bhil. As the flood rises, the silt-laden water flows in and comes to rest when the silt is deposited, and as the water level falls, the decanted water drains off, the ebb and flow are as a rule sufficient to keep this channel open, and the fall in the Ganges is not so rapid as to cause disturbance to the newly deposited silt. This is the system in use on the brickfields on the banks of the Hooghly River, where the pits from which earth has been excavated are annually made good with river silt and nothing more simple and effective can be imagined. Some years ago I designed a decanting sluice so as to prevent the tidal fall disturbing the silt-settling action, but in the Ganges the fluctuations of level are so gradual that this is not necessary, and all that is required is that a still back water be formed.

"5. My personal experience of the open mouth silt-catching pit is worth recording. Some years ago, I had an abutment of a long iron viaduct outflanked on the down stream side, and commenced enclosing this within a ring bund working in segments. The first year the silt had accumulated to low flood level; the open mouth was then reduced year by year until average ground level was attained, when it was closed, and the embankment made secure. On the other hand, in a somewhat similar case, through not grasping the local conditions, I failed signally in my attempts, but fortunately with no bad results. This is merely recounted to show that each river has its own special character, and that its moods must be studied before anything approaching satisfactory results by utilising it can be expected. It is with the object of gaining preliminary information that it was urged in my note of the 1st October 1910 that silt observations be extensively made; as the proportion of silt in the water varies from $\frac{1}{218}$ in the Megna, $\frac{1}{300}$ in the Sone, $\frac{1}{1,100}$ in the Bhagirathi, to $\frac{1}{2,317}$ in the Kusiara Rivers. Bonificazone, or the improvement of land by drainage and silt deposit, is a subject which has come to stay in India. In Italy 'it is considered a

grave error not to profit by fertile silt whenever it is available,' and it is inconceivable that this view will not in time be generally held in this country also."

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Fish Culture as a means of controlling Malaria in Rice Fields. (Bekämpfung der Malaria durch Karpfen). *Oesterreichische Fischerei-Zeitung*, S. 86, Wien, März 1, 1911.

There are about 200,000 hectares of rice fields in the valley of the Po, which are covered in summer with water to a depth of from 20 to 30 cm. The rice zone is very frequently infested with malaria.

The breeding of carp has been tried in the rice fields, and for some years past excellent results have been obtained. The young fish, barely 10 mm. in length, are put into the fields from the end of June. By the month of September, they are already large, and are found in sufficient quantity to yield a quintal of fish per hectare.*

Four or five francs will buy enough fry to stock a hectare, and there is no further expenditure. Rice-field carps are well nourished and have a fine flavour. The rice also seems to derive benefit from the presence of the carp, for the fields where these fish are raised have given an additional 5 to 6 quintals of rice per hectare.

The fish clear the plants of vegetable and animal enemies and devour the larvæ of the Anopheles thus contributing to render the malarial zone healthy. (*Bulletin No.* 3, *March* 1911, *of the Bureau of Agricultural Intelligence and of Plant Diseases, International Institute of Agriculture, Rome.*)

From another abstract in the same Bulletin, it appears that the excellent results probably referred to, were obtained under the direction of the Hydrobiological Station of the Municipality of Milan, where no doubt adequate expert supervision was available. Elsewhere the practice was tried and abandoned. The

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* Quintal per hectare = 20 seers per acre.

fate of this new industry will be watched with interest in India.

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GRAFTING MANGOES.—The following suggestions for experiments in the grafting of mangoes are taken from a lecture read by W. Burns, B.SC., Economic Botanist, Bombay, to the members of the Deccan Agricultural Association.

"The usual method practised in the Deccan is to put seeds of any kind of mango into small pots. These seeds develop into seedlings, and, when two or three years old, are taken out beside large trees of good quality and have scions from these trees grafted on them by the tongue-graft by approach method, or by simple enarching. In the latter form two cut surfaces are placed together. In the former a tongue is cut in both stock and scion and the union is more secure. I have not seen any other method of grafting practised by ordinary growers. In the Bassein and Ganeshkhind Botanical Gardens we occasionally cut off a branch from a tree of good variety and graft it in the nursery on the seedling by means of the whip graft. Both these methods have one serious disadvantage. The seedling as it develops finds no room for its roots in the small pot, and its growth of stem is likewise stunted. Now it is impossible to graft satisfactorily on a thin stock, and moreover, when a root system that has been cramped in a pot is placed in the field, it is difficult for these stunted and tangled roots to take a grip of their new situation and the whole plant may languish. The obvious remedy for this is to plant the mango stones for stocks right into the pits, and graft on the seedlings from them, in the field, by means of the whip graft. By planting the seeds at once in the pits, we get a strong healthy root system in a natural relation with its surroundings, and a correspondingly strong and healthy stem on which we can easily graft. There are, however, certain objections which may be raised against this method:—(1) that on the whole the whip graft is not so successful as the approach method; (2) that the graft is exposed to sun, wind and animals and is thus not likely to take. Are these objections valid?

The whip graft is, I believe, in the hands of an expert, as satisfactory as the tongue-graft by approach. The exposure of the grafted plant can be avoided by properly constructed shades and shelters. I recommend, for experiment, the planting of mango stones in the field where the plantation is finally to be, and the grafting on the seedling stocks there raised, of good scions, by means of the whip graft. The whip graft is made by a long slanting cut, in scion and stock, of equal thickness; and the putting of these together, as a lash is tied to a whip handle. A modification of this method, which may be also tried experimentally, is to make the tongue-graft by approach in the usual way, and then take the grafted plant to the field and use its branches as scions, to graft by tongue, by approach, on the mango stocks there raised. Both the methods I have just described are, I think, well worthy of a trial, and have the great advantage of giving a vigorous and natural root system to the plant. Dr. Mann, again, tells me that a similar point in tea culture has been decided in favour of the nursery raising of seedlings.

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One cannot leave the subject of grafting without some reference to the systems of crown and side grafting. If the top of a tree, or of a thick branch, has become useless, either through attacks of "Bandgul," insects or any other cause, there is still no necessity to lose the tree or the branch. Cut off the diseased top of the tree, and, between the bark and the wood, insert one or more scions, of good variety, and carefully tie and cover. Where these crown grafts take, their growth is astonishing. They are supplied by an enormous root system and, consequently, go on making one growth continuously after another, so that, in a very short time, the amputated top is replaced. Side grafting is a similar method applied to the side of a tree. A method of grafting termed *strap grafting*, recently described in an Australian journal, is one which I have not tried. Budding the mango has been recommended in various journals from time to time. Experiments with budding in Ganeshkhind and Bassein gardens

have, however, proved unsuccessful; and I see no reason for abandoning the easy and well-tried methods of grafting for the difficult and doubtful process of budding."

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A NOTE ON THE USES OF CLEISTANTHUS COLLINUS IN THE NAGPUR DIVISION OF THE CENTRAL PROVINCES:—Cleistanthus collinus Benth.—Syn. *Lebidieropsis orbicularis*, Vern. *Garari* is a small deciduous tree most commonly growing as coppice. The information mentioned by Dr. Watt in the Dictionary of Economic Products is the statement made by Roxburgh that the bark or outer crust of the capsule is reported to be exceedingly poisonous, and it is stated by the Rev. Dr. Campbell that the fruit and bark are employed in Chota Nagpur to poison fish. The following additional notes on the poisonous properties of the tree are of interest. An enquiry arose out of the fact that a few leaves with some bark from the root of a tree were sent in for identification; the only information supplied was that they were taken from a tree very common in Chanda which was noted for its hard wood. The reason for the enquiry was that a woman had confessed to killing her husband by giving him a decoction of the bark of the root. The specimen was identified as *Cleistanthus collinus* and the following additional information came to light in the enquiry. A party of Gonds from Balaghat district who had come to the bazar were shown the specimen and recognising it said that the leaves were poisonous and the root much more so. They used the leaves for poisoning fish in streams. The stream was dammed up and a number of basketfuls of leaves were thrown on the water. After two or three days when the leaves had rotted the fish were killed. Mr. Low, Director of Agriculture, was able to supplement this information. In Balaghat district there was a case of poisoning in which a woman was accused of killing her husband by giving him a decoction of the root. The case could not be proved as no poison could be isolated. The evidence, however, clearly pointed to the cause of death being the bark or root of the *Garari*. Another interesting use is made of this

plant in the same district. When the rice crop is attacked by stem borer, it is the custom to throw the leaves on to the water in the rice land in order to prevent the spread of the insect.

With regard to the chemical nature of the poison Greshoff mentions that there is Hydrocyanic acid present (*Kew Bulletin*, 1910, 10, 403), while Dekker has separated from the bark tannin, saponin and a crystalline phytosterin (Pharm. Weekblad, 46, 16, 20).—(R. J. D. GRAHAM.)

REVIEWS.

RAMIE (RHEA), CHINA GRASS. THE NEW TEXTILE FIBRE BY H. A. CARTER.

THE volume before us, composed of sixteen chapters and covering 140 pages, contains a great deal of information regarding rhea, ramie or China grass, which cannot fail to be of use to anyone desiring, in a compact form, a fairly comprehensive survey of the whole subject.

The early part of the work deals with the botanical and agricultural sides of the question, following which the technical problems involved in the processes of decorticating, degumming, spinning and weaving receive attention. The last seven chapters include :—

(*a*) Statistical and general commercial information regarding the progress of the rhea manufacturing industry in Great Britain, the continent of Europe, America, South Africa and China.

(*b*) A specially interesting account of the numerous uses to which ramie is capable of being put.

The order Urticaceæ, the nettle family, to which the genus Boehmeria (containing rhea) belongs, includes many valuable fibre-producing plants. Owing, however, to the difficulties attending their cultivation and extraction, none of them, excepting ramie, is being commercially exploited. There are two species of true rhea, *viz.* :—

(A) *Boehmeria tenacissima.*

(B) ,, *nivea.*

The former is a truly tropical plant, while the latter, which is distinguished by the white undersurface of its leaves, is capable of cultivation in semi-tropical, and even in temperate,

climates. *Boehmeria nivea* is the source of the rhea fibre produced in China and known as "China Grass."

It is also the plant with which the numerous attempts to introduce rhea cultivation, on a large scale, into India have been made. Both the varieties of *Boehmeria* are botanically distinct from the "Ban" or wild rhea, which is *Villebrunea integrifolia*, and which is found in the jungles of Assam, the Terai and in similar tracts in other parts of India. All three plants share the property of containing excellent fibre.

The fibre of rhea, like those of jute (*Corchorus capsularis*) San Hemp (*Crotalaria juncea*), *mestapat* or Bimlipatam jute (*Hibiscus cannabinus*), is found in the bark of the plant. Of the latter commonly occurring fibres, San Hemp is the only one which approaches rhea in regard to quality ; its cellulose content, which indicates durability, being approximately the same as that of rhea fibre. In all other respects rhea is incontestably superior. Its ultimate filaments are probably four times as long as those of any other fibre. Its strength is three times that of hemp, four times that of flax and eight times that of cotton. Nevertheless, its fibre can be separated to such a degree as to enable it to be spun and woven into materials almost as fine as those made from silk. It is less flexible than cotton; but this apparent defect might, quite possibly, be removed by a modification of the treatment the fibre undergoes in the course of preparation. It is as white as bleached cotton and its lustre is superior to that of fine linen.

With all these superlative qualities, rhea may well be called the king of vegetable fibres, and it is little wonder that persistent efforts have been, and are still being, made, both by agriculturists and by manufacturers, to overcome the difficulties which stand in the way of its being used on as cale more commensurate with its value than is the case at present. These difficulties are more than ordinarily complex. The plant is far more sensitive than those at present commonly grown for fibre. It demands the richest lands, with copious manure, and while it requires a heavy and evenly distributed rainfall, it is killed at once by

anything approaching water-logging of the soil. Further, the crop occupies the land for several years, during which no other crop can be produced and, as rhea takes two years, after planting, to mature, the land is virtually unproductive during this period.

When the crop has been produced, it is found that the fibre cannot be extracted by the comparatively cheap method of retting, such as is employed in the case of jute and other similar fibres. It is necessary, therefore, for this purpose, to resort, either to extremely tedious manual methods, or, to expensive machinery. The manual methods are so slow as to be impossible of application, excepting when the cultivation is on a very small scale, unless efficient labour is plentiful and extremely cheap. On the other hand, the decorticating machines at present on the market, though expensive, are by no means perfect, as they tend to break up, and therefore to lose, a considerable proportion of the fibre during the extraction process. They are particularly wasteful with short stems which, in some cases, cannot be cleaned at all. Under such conditions, it is obviously only the long stems which can be counted on as fibre producers and the difficulty of the agricultural problem is therefore intensified. In 1869 and again in 1877, the Government of India offered prizes of £5,000 (Rs. 75,000) and £2,000 (Rs. 30,000) respectively for machines or processes by means of which rhea could be economically and efficiently extracted; but the prizes were, in view of the absence of competitors of sufficient merit, ultimately withdrawn.

Even after its extraction, a subsequent chemical treatment of the fibre, called degumming, is necessary before it can be prepared for spinning.

It is obvious therefore that the expenses of the production and extraction of rhea are very great; but if these were compensated by a correspondingly high price for the prepared fibre, there would still be a prospect of a profit to the cultivator. Unfortunately, it can hardly be doubted, that the price of rhea is not commensurate with its real value, as compared with other

fibres; the result being that the amount of rhea produced is very small indeed. Even including China the total area under rhea must be far less than 100,000 acres, *i.e.*, less than one-thirtieth of the area devoted to jute in Bengal.

The rhea fibre produced in China is entirely the result of a cottage industry. It is really only partially cleaned, being, more or less, in the form of ribbons, which retain the original form of the bark. The method of extraction of "China Grass," though tedious, is simple and is entirely a manual process. The price of "China Grass" in China is said to be about £24 per ton or about Rs. 13 per maund.

The cultivation and extraction of rhea in Northern Bengal and in parts of Assam is probably carried out under conditions rather similar to those obtaining in China. In Northern Bengal the individual areas are very small indeed, varying usually from a patch containing a few roots, to about $\frac{1}{10}$ acre, the average probably being nearer $\frac{1}{60}$ acre. The cultivation of rhea is, of course, by no means universal amongst the raiyats and the produce is entirely consumed in the local markets where its price is said to vary from Rs. 2 to Rs. 6 per seer, *i.e.*, at the rate of about £150 per ton. The method of extraction is described as extremely tedious and the cultivation is expensive on account of the large amount of manure required. With their jute cultivation, far easier, cheaper and very profitable, even at much lower prices than Rs. 10 per maund,* it is unlikely that the raiyats of Bengal would take up the cultivation of rhea for Rs. 13 per maund.

Even the machine-cleaned rhea, produced five years ago by the Bengal rhea syndicate (since liquidated), was only worth from £28 to £36 per ton landed in London. The manufacturers, by whom, of course, these prices are fixed, contend that they cannot afford to pay more for the raw material; because the position of rhea fabrics in the world's markets is not sufficiently secure, to enable them to raise the price of the finished product without automatically diminishing the consumption. For the

* Jute has reached this value twice in the last five years.

present, therefore, it is probable that China will continue to supply the world's demand for rhea.

The foregoing remarks are suggested by a perusal of Mr. Carter's book. The chapters on the agricultural side of the question are, in our opinion, too optimistic. We do not, for instance, find ourselves in whole-hearted agreement with statements like the following :—"and experts are agreed that, if the authorities will foster and protect the cultivation, India will become one of the most important rhea-producing countries in the world." Even if there were large areas of land in India, naturally suited for the cultivation of rhea, it must not be forgotten that such lands are also capable of producing heavy yields of crops which might, apart from the less trouble involved in their cultivation, pay better than rhea could hope to do, at present prices. Tobacco and jute may be quoted as possible instances of such crops in Northern Bengal. As a source of accurate first-hand information on the agricultural aspect of the rhea problem, we would prefer to recommend to intending cultivators of rhea the article "Rhea Experiments" contributed by Mr. B. Coventry, Officiating Inspector-General of Agriculture, to the *Agricultural Journal of India* (Vol. II, Part I, January 1907).

The chapter on decorticators contains descriptions with illustrations of the Lehmann, Faure and Schlichten machines. Of these, one or other of the forms of the Faure machine would, at present, appear to be the most satisfactory because, being at least as efficient as other machines on the market, units of the small type might be worked on a comparatively small area. On the other hand, a number of such machines can be economically linked on a larger area; or, one of a larger type could be substituted. The Faure machine can only be relied on to produce $2\frac{1}{2}$ per cent. of good fibre out of a possible 5 per cent., the remainder being broken or cut away in the process of decortication. Such fibre as is cleaned is, however, of good quality: the parallelism of the fibres in the ribbons is not seriously disturbed and the fibre obtained from them is equal to that extracted, in a similar

manner, from China Grass. A disadvantage of this machine which is probably equally characteristic of other decorticators is its inability to deal satisfactorily with short stems. This being so, it is obviously only the longer stems—say, those over 3 ft. long—which can be taken into account in estimating the possible yield of fibre per acre. In some cases the proportion of short stems may be so large as to cause, by their inclusion or rejection as fibre yielders, the difference between success and failure. It is just possible for instance that if, in the recent expensive experiments in Behar, all the stems, long and short, could have been economically dealt with, the results might have justified a continuance of the cultivation. The matter is thus obviously a serious one, well worthy of the attention of engineers. It is only due to the Faure machine to say that, in the trials in India, it never had the best crops to work on and that, in a district better suited to the growth of rhea than Behar, it might yield quite sufficiently satisfactory results.

A new ramie decorticator has recently been reported from America, *viz.*, the "Schlichten" machine, which has been favourably reported on by the American Government Botanist. The tests were, however, performed with dry retted hemp, and not with ramie, so that the recommendation would appear to be of doubtful value. The machine is a large one, weighing 3 tons and requiring 7 h.-p. to work it. It could therefore only be used on a large plantation.

In the chapter dealing with the history (subsequent to the year 1853) of the ramie trade in Great Britain, the author shows that it is by no means a uniform record of success. There are, however, at the present time several mills in England which are profitable enterprises. "Sail-cloths and large quantities of incandescent gas mantles are manufactured at these premises and the enterprises have been at work successfully for some years." We learn with interest that the sails of the yacht "Shamrock I," in the races for the America cup, were made of ramie instead of flax. Being the strongest of all fibres and, a the same time, lighter than flax, it is obvious that "vessels ca

carry a greater expanse of ramie sail-cloth than if their canvas were made of flax."

In this connection the author asks why British-grown ramie cannot wholly replace the foreign-grown flax for which Great Britain pays some millions sterling annually. "Degummed in a satisfactory manner, and rightly combed afterwards, ramie is quite equal to these" (the finest grades of foreign flax) "in regard to fineness, strength, elasticity, ductility and all those good qualities which go to make a textile fibre—identical in appearance to flax, while considerably cheaper." This is all perfectly true; but if such a desirable consummation is to take place, the price of rhea must rise before its cultivation in India would be worth while. The present position is only to be explained by supposing (*a*) that the manufacturers at present in the trade, content with a handsome profit on their working, are not anxious to see a great extension of the trade and a consequent increase of competition, which is not likely to benefit them. In this connection it may be remarked that the average annual dividend of the Erste Deutsche Ramie Gesellschaft of Emmendingen, for the last twelve years, has been nearly 9 per cent., but during the last five years it has averaged 12 per cent. and in 1907 and in 1908 it was 15 per cent. The only other possible explanation of the anomalous position of rhea in the world's markets is, (*b*) that the present demand for rhea fabrics is not sufficient to outstrip the production of "China Grass." In this case it is not to the interest of the Indian planter, or cultivator, to compete with China in order to lower the price of the raw material to benefit the European manufacturer; but it might, on the other hand, be possible for profitable rhea-manufacturing concerns to be taken up in India, somewhat in the manner suggested on p. 85 of the book under review. A rhea manufactory in India should have the same chance of success as the similar enterprises in Europe, which are, as we have seen, making handsome profits. In the event of a rise in the price of raw material, Indian concerns would still be in as favourable a position as before; especially if it became worth the while of the Indian cultivator to produce

rhea on a large scale. Such a scheme as this would appear to be the only way, at present, of developing a rhea industry in India. Preliminary efforts, it may be said, are already being made in this direction.

A few words regarding the manifold uses to which rhea can be put may be interesting. "As the strongest of all fibres and by reason of its non-liability to rot when immersed in water, it is especially suited for the manufacture of sail-cloth, tent canvas, ropes, cords, fishing lines and nets. For these purposes it is unquestionably superior to all other textiles in regard to its lasting property. Woven into tent canvas for military purposes, tents made from the fibre can be transported in less wagon space during warfare, a matter of the first moment. Fire engine hose...belting and...towellings, etc., etc." It is more serviceable than cotton in the manufacture of water-proof goods, and everyone knows now that rhea makes the best framework for incandescent gas mantles. "The best quality of fibre is spun into yarns used in the manufacture of brocades, damasks, fine tapestries...plushes, velvets, lace goods...and goods which can supersede some of the finest qualities of linen." Most people know that rhea materials for underclothing and summer suits can now be obtained ; but few have tried them. It is well worth their while to do so.

The following quotations from Mr. Coventry's article (*loc. cit.*), form an admirable summary of the position of rhea, with which we are in entire agreement. They are well worth reproducing here:—"The price of rhea is regulated by the supply from China, which is the over-production of an indigenous industry; the demand is from a small handful of European spinners who appear entirely to control the trade."......"The prices which spinners are now offering for the raw product are quite out of proportion to its intrinsic merits, and the consequence is that there is no inducement for cultivators to extend their operations. The quality of the land and the high class of agriculture required for the growth of rhea call for a greater value for the raw product...... there are other crops that pay better than rhea. If spinners are

truly desirous of developing this important crop, they must...... offer prices more commensurate with the intrinsic value of the product."......When we consider that rhea is "both a textile and a cordage fibre," the lowness of its price "is a matter for some astonishment." Manilla Hemp and Agave are worth from £20 to £80 per ton; flax from £30 to £150 per ton and the price of jute, a fibre of an entirely lower class, has twice, in the last five years, exceeded £25 per ton. In view of these figures Mr. Coventry may well ask :—"How is it that the finest fibre in the world can, with difficulty, realise £26 to £38 per ton?"

The sense of these remarks is pertinent to this review; because our perusal of Mr. Carter's book seems to indicate that he holds rather the view of the European manufacturer than that of the producer, in regard to the price of raw rhea. We believe it probable that, if the price of the fibre were to rise to £40 per ton (Rs. 22 per maund), serious attempts might be made in India to extend its cultivation, with a view to export; but until some such substantial inducement is made, it is not likely that the Indian planter or cultivator will respond in any degree.

In conclusion, we wish to say that, although we do not agree with all Mr. Carter's views in regard to the agricultural side of the rhea question, we have, nevertheless, read his book with interest. The chapters dealing with the manufacture of rhea fabrics and also his review of the prospects of rhea in different parts of the world are full of information. The numerous illustrations are very well done and there is a fair index.

The book is published by the Technical Publishing Co., Ltd., 55 & 56, Chancery Lane, London, E.C.—(R. S. FINLOW.)

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REPORT OF THE INDIGO RESEARCH STATION, SIRSIAH, FOR THE YEAR 1910-1911. BY CYRIL BERGTHEIL, SCIENTIFIC OFFICER, BEHAR INDIGO PLANTERS' ASSOCIATION, MUZAFFARPUR.

THE report is very disappointing owing to the fact that the biological work of the past two years was destroyed by the disastrous flood of last August. This is the more to be regretted

because of the certain indications which exist that there is a wide scope for the improvement of the Indigo-producing power of the plant. To quote Mr. Bergtheil's own words : "Out of 100 plants, all under uniform conditions and apparently at the same stage of growth, analysed within a fortnight in one field, the highest was found to be capable of yielding ·79 per cent. of indigotin from the leaf and the lowest ·34 per cent., the average yielding power of the whole lot being ·52 per cent. This indicates very much wider variation than the results previously recorded from smaller numbers of analyses have done, and means that the possibilities of improvement by selection are, correspondingly, even greater than had formerly been supposed .. ..we can, I think, now state with assurance that the Java plant, as it now stands, can be improved in its potential indigo-yielding power by an amount of the order of 50 per cent. at least."

This is an important statement and let us hope that if not all, at any rate a large proportion of this increase may eventually be obtainable on a commercial scale, for it would go a long way in establishing natural indigo on a secure basis.—(EDITOR.)

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DISEASES OF THE ARECA PALM I : KOLEROGA. BY LESLIE C. COLEMAN, M.A., Ph.D., MYCOLOGIST AND ENTOMOLOGIST TO THE GOVERNMENT OF MYSORE. Department of Agriculture, Mysore State, Mycological Series, Bulletin No. 2, 1910.

THIS is a very full account of the disease of Areca palms in South India, first described under the local name of *Koleroga* in the *Agricultural Journal of India*, Vol. I, 1906, p. 399. Dr. Coleman considers it to be one of the worst fungus diseases to be found in India. The area affected consists of one large continuous tract in the western portion of Mysore extending over the ghats into Canara, and a second smaller one in South Malabar and the adjacent portion of Cochin State. This is all a region of high rainfall, reaching about 300 inches in the ghats themselves. Within this area the Areca nut is one of the most

valuable crops grown, the returns from a successful garden being very high. In the western part of Mysore the total value of the crop exceeds 40 lakhs of rupees and the revenue yielded by it to Government is about two lakhs yearly.

The disease attacks chiefly the nuts, which are rotted and fall off. Occasionally the top of the tree is also infected, the bud being destroyed and the palm killed. In badly affected gardens the loss may amount to 75 per cent. or even practically the whole crop. Dr. Coleman estimates the annual loss to be at least 3 to 4 lakhs of rupees. The first appearance is usually soon after the monsoon breaks in July, and the nuts continue to fall for some months. Fallen nuts in the early stage of the disease are found to have lost their clear green colour and usually the surface is partially covered with a soft whitish growth. This growth consists of the mycelium of the fungus *Phytophthora omnivora* var. *Arecæ*, which causes the disease. In moist weather this fungus gives rise to numerous small swimming spores, which are set free into the films of water covering the bunches or are carried in rain drops from nut to nut. After a short period of motion the spores come to rest and germinate by a little thread-like filament which is capable of entering into the tissues of the nut and also of other parts of the crown of the palm. Here it grows and extends throughout the living cells, killing them and rotting the tissues. Ultimately groups of filaments burst out on to the surface where they form a new crop of spores. In addition to this evanescent type of spore a durable form is produced sexually which is probably capable of preserving its vitality for considerable periods. This has not so far been found naturally on the Areca palm itself, but has developed in Dr. Coleman's cultures and also on other plants inoculated with the *Areca phytophthora.* Since the disease remains over from year to year in the gardens, it is not unlikely that further search will result in finding the resting spores on the palm itself. Besides the Areca palm, Dr. Coleman succeeded in inoculating a number of other plants. In Europe and elsewhere the same fungus is known to attack many different species, some of economic

importance. The same is quite likely to be the case in India. In one instance, however, that of the fruit rot of Cacao so destructive in Ceylon and indeed wherever Cacao is grown, another *Phytophthora* was found, which Dr. Coleman showed was not identical with the Areca parasite.

One of the most interesting sections of the paper is that in which the experiments in the treatment of the disease are described. The Areca growers have themselves devised a method which, though troublesome and imperfect, is still of interest as being one of the few cases of intelligent attempt made to check plant diseases in India. It consists of binding covers made of the basal sheaths of the Areca palm leaves over the bunches, to keep the rain off them. Since water on the nuts is necessary for the spread of the disease by spores, anything which tends to keep them dry will naturally diminish the spread. But these covers are not universally used, are easily dislodged by the wind or rotted by the rain and the method is not very successful. Hence Dr. Coleman carried out an extensive series of spraying experiments, with more promising results. The mixture used was that known as Bordeaux mixture, made of 5 lbs. copper sulphate, 5 lbs. quick-lime and 25 gallons water. To this was added resin and washing soda to increase its adhesive properties. Sufficient to spray one acre costs Rs. 3 to Rs. 4, but it is hoped to reduce this. The mixture was applied by means of a small sprayer, worked by compressed air and capable of being slung on the back of a palm climber. The climbers are very expert in ascending the palms and even habitually swing themselves from tree to tree without the labour of descending and remounting. This enables them to spray a large number of trees in a day, about three times as many as could be provided with bunch covers under the old system.

The results obtained in the first year's experiments show that a single application made early in June just before the monsoon, was more effective in checking the disease than using covers. Thus in one garden the percentage of loss of nuts when sprayed was between 6 and 7, according to the date of the

spraying, when tied with covers 10, and when untreated 40. These experiments are being continued, and show considerable promise of success.

The bulletin is copiously illustrated and an abstract of the scientific work done in connection with the disease has been published in the Annales Mycologici for December 1910.—(E. J. BUTLER.)

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BULLETIN OF THE BUREAU OF AGRICULTURAL INTELLIGENCE AND OF PLANT DISEASES—ISSUED BY THE INTERNATIONAL INSTITUTE OF AGRICULTURE.

THIS Bulletin is issued monthly, and promises to be an exceedingly useful publication. It consists of abstracts taken exclusively from books, periodicals, bulletins and other publications received in the Library of the Institute in Rome, where they are dealt with by a staff of abstractors.

The abstracts are less numerous than those given in the Experiment Station Record of the United States Department of Agriculture but fuller, and contain, in many cases, sufficiently detailed information to be of value without reference to the original publications. Provided that all publications of importance are received by the Institute and that the abstracting is done with scientific discrimination, both these differences are in favour of the new publication, particularly from the point of view of the agriculturist who has not access to a large library.

At present the abstracts are merely grouped under cognate heads, but arrangements will no doubt be made for indexing as the numbers accumulate.

It is to be hoped that the Institute will receive such support from the agricultural public, as well as from official and scientific bodies, as will ensure, both that all important publications of agricultural interest reach the Library in Rome and that an efficient staff of abstractors and translators be maintained.—(A. C. DOBBS.)

BULLETIN NO. 200 OF THE UNIVERSITY OF WISCONSIN EXPERIMENTAL STATION, WISCONSIN, U. S. A.

THIS Bulletin should be read by all interested in the economical production of milk. It shews that in the North-West of the United States, rations of a very wide albuminoid ratio are successfully fed to heavy milking cows. The bulletin is based on the results of trials extending over 9 years, with a herd of cows of extraordinary productive capacity, which for 6 out of the 9 years gave an average of over 7,600 pounds a year per cow of milk containing about 4·2 per cent. of butter fat. As a result of these trials the albuminoid ratio recommended for the ration of large cows producing not more than 1lb. of butter fat daily, is wider than 1 to 8 ; while a ratio narrower than 1 to 7 is recommended only for the feed of small cows producing over $1\frac{1}{4}$lbs. of butter fat daily.

These recommendations are contrary to the teachings of European Agricultural Scientists who have recommended the feeding of at least 50 per cent. more protein under similar circumstances. The American figures seem to be more in accordance with practical experience, and, as their adoption would effect a saving of probably half the expenditure that would be incurred, for purchased foods, by the adoption of the standards generally recommended in England and other European countries, owners of dairy herds who are guided by scientific principles in feeding their cattle would do well to give the recommendations contained in this bulletin a trial.—(A. C. DOBBS.)

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BOLLETTINO DEL LABORATORIO DI ZOOLOGIA GENERALE E AGRARIA DELLA R. SCUOLA SUPERIORE D'AGRICOLTURA IN PORTICI. Volume IV, Portici; 1910. (Pp. 354, text-fig. 145. Price 20 Lire).

THIS, the latest part of a series which commenced in 1907 and which promises to give us an annual volume, forms a worthy companion to its three predecessors. Although nominally devoted to general and agricultural zoology, all four volumes are

almost entirely occupied with papers on Economic Entomology, the leading feature being the careful working out of the life-histories and bionomics of some of the insect-pests most seriously prejudicial to agriculture in Italy. It need scarcely be stated here that an important point, to which attention must be directed in working out the life-history of an insect-pest with a view to reducing its numbers, is the consideration of the enemies which normally prey on it and keep it within bounds. This fact receives especial prominence in the publication under review. We are all familiar with the old rhyme which asserts that

> "Big fleas have little fleas
> Upon their backs to bite 'em,
> And little fleas have lesser fleas
> And so *ad infinitum*,"

but it is as a rule only the professed Entomologist who realises the immense complexity of the subject of parasitism. A destructive insect, such as a Caterpillar, may, for example, be parasitised by a second insect which lays its eggs in, and whose larvæ live on the tissues of the first; this second insect is beneficial as it destroys the first, but may itself be parasitised by a third insect, which we must look on as injurious because it destroys the beneficial parasite; and this third insect may be parasitised in its turn by yet a fourth, which lives at its expense; and so on. It is therefore not every parasitic insect which is beneficial, a fact which is often not realised or forgotten. Sometimes, indeed, a parasite may fill a double rôle, as is the case of a small Chalcid mentioned in the present volume, which is beneficial when it attacks the caterpillars of *Sitotroga cerealella* (the destructive Angoumois Grain Moth), but injurious when it is a hyperparasite on *Apanteles glomeratus* which is itself a parasite of the Cabbage Butterfly (*Pieris brassicæ*).

Many of the species dealt with in these volumes are not as yet known from India; but many of the genera are identical and the observations on habits, damage done, and means of prevention, cannot fail to interest the Entomological worker in

India. The text-figures are excellent and the text itself written in a style combining lucidity with scientific exactitude. We congratulate the Portici School of Agriculture on the production of an extremely interesting and useful series of papers.—(T. Bainbrigge Fletcher.)

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Handbook of the Destructive Insects of Victoria, Part V, by C. French, Government Entomologist.

This is the fifth part of an eminently useful series of small Handbooks initiated by Mr. French twenty years ago and intended to be completed by a sixth part, now in course of preparation. All the insects dealt with are well figured in colour, and a short account is given of their life-history and means of control.

As in the preceding volumes, of which the fourth was reviewed in this Journal (Vol. V, pages 182-183), many of the insects dealt with are exclusively Australian, but several of these have representative species in India, very similar in their relationships, habits, damage and means of control. Such are the "Butterfly of the Orange" of which we have two common and destructive species belonging to the same group; "the Dark-striped Tiger Moth" (*Diacrisia canescens*), represented in India by the Behar Hairy Caterpillar (*D. obliqua*); and "Boisduval's Fig-tree Borer" (*Batocera boisduvali*), paralleled by our common Mango Borer (*B. rubus*).

A few of the insects dealt with, chiefly cosmopolitan or widely-distributed and well-known species, are identical with ours; such are the Sweet Potato Weevil (*Cylas formicarius*), the Rice Weevil (*Calandra oryzæ*) and the Grain Weevil (*C. granaria*).

Besides destructive insects, the volume under review contains coloured figures and descriptions of twelve Australian birds which are useful to the agriculturist as devourers of noxious insects. Following Jerdon's account, the Spine-tailed Swift (*Chaetura caudacuta*, Latham) is stated to breed in the Himalayas, but this is not an Indian bird; our white-necked Spine-tail (*Ch. nudipes*, Hodg.), which was erroneously identified by Jerdon

as the Australian species, being confined to Northern India. The subject of insectivorous birds is one which has lately received a certain amount of attention in India, and a Memoir of this Department, on the actual food of Indian birds, has lately been published.

The subject of the importation of insect and fungal pests is one which is receiving due attention in Victoria and an interesting report by the Senior Inspector of Fruit Exports and Imports embodies the regulations now in operation. Not only Nursery Stock, but bananas, *Citrus* fruits, potatoes and tomatoes are only allowed to be imported under a system of rigid inspection. It is interesting to note also that the local transfer of potatoes is under strict supervision; unfortunately, such measures of internal control seem impracticable in India, where the Potato Moth (a lately introduced pest) is steadily spreading from one district to another. As Mr. French remarks (p. 82), we cannot be too careful in regard to shipments, as, once the pests are introduced, they usually come to stay."—(T. BAINBRIGGE FLETCHER.)

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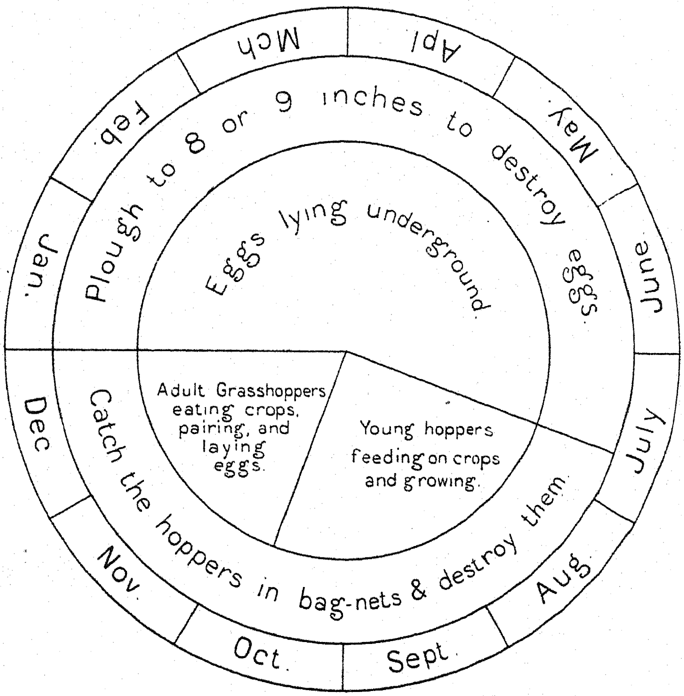
"THE JOLA OR DECCAN GRASSHOPPER (COLEMANIA SPHENARIOIDES)." DR. L. C. COLEMAN. Mysore State Department of Agriculture, Entomological Bulletin, No. 2. Bangalore: Government Press, 1911. Price Re. 1.

THIS Bulletin, comprising 43 pages and 10 plates (of which two are coloured) and 8 figures in the text, deals with a wingless grasshopper, native to the South of India, and which has quite recently manifested a liking for crops. It is particularly to be noticed that this grasshopper is not an introduced species but an indigenous form which has apparently, until within the last few years, led a comparatively harmless existence in the Deccan as a grass-feeder; owing to the extension of cultivation or other causes it has however exhibited a preference for cultivated cereals, and the more abundant nutriment thereby afforded has enabled it to increase its numbers until it has become a very serious pest.

In the case of cereals, indeed, "not only are the leaves eaten but also the grains in the heads, the result being that in a severely attacked field practically nothing is left but the stalks or stems of the plants and the empty ears ;" in the case of pulses, however, the grasshopper contents itself with eating the leaves and flowers, leaving the pods and seeds untouched. Although the adult grasshopper is incapable of flight, it appears to be spreading rapidly in cultivated tracts, being largely assisted in its distribution by the transport of individuals in carts, etc., across natural obstacles such as streams.

The life-history is very similar to that of the Cane and Rice Grasshopper, the eggs hatching after the early monsoon rains have fallen in July, the young hoppers feeding from August to October, the adults damaging the crops in November-December, then pairing and dying off, leaving their eggs hidden in the soil. The diagram shows the annual life-cycle in graphic



form, and the remedial measures to be adopted at different times of the year. These latter are the same as in the case of the

Cane and Rice Grasshopper and consist in (*i*) giving a deep ploughing whilst the egg-masses are still in the soil to bury them to a depth from which the young hoppers cannot emerge or destroy them by exposure on the surface ; (*ii*) catching the hoppers (especially, of course, when they are young and before they have done much damage) by means of large bag-nets dragged through the young crops. As the author remarks, however, "the work of bagging should be looked upon in the same light as weeding, something which should be repeated at regular intervals." If hoppers do not come in from surrounding unbagged land, three or four baggings should be sufficient. In a case cited, where a cultivator owning eight acres in the middle of a badly infested area deep-ploughed his land and bagged enthusiastically in 1910, the crop harvested was worth Rs. 240 ; the deep-ploughing had reduced weeding-expenses by Rs. 10, whilst the owner estimated the expenses attached to bagging the whole area at only Rs. 6-9 including cost of bag. In 1909, when no remedial measures were adopted, the total outturn from these eight acres was only valued at Rs. 10 and hardly repaid the work done on the land. These figures speak for themselves.

The list of natural enemies of this grasshopper is very meagre, comprising only a few birds, a lizard, a predaceous fly, and a Blister Beetle whose larva feeds on the egg-masses ; probably further research will be repaid by the discovery of endophagous parasites which may be utilised in fighting this pest.

We notice one slight *lapsus calami;* the predaceous fly figured on Plate VII, fig. 8, being described on page 42 as a *Syrphus*; on page 26 it is correctly referred to the *Asilidæ*.—(T. BAINBRIGGE FLETCHER.)

EXPLANATION OF PLATE OF DECCAN GRASSHOPPER.

(*Colemania sphenarioides, Bol.*)

Fig. 1. Shows a *bajra* plant attacked by the grasshoppers. The leaves have been gnawed and nearly all the grains eaten.

Fig. 2. Shows two adult hoppers on the ground ; the individual on the left hand has thrust its abdomen into the soil and is laying eggs.

THE YEAR BOOK OF THE UNITED STATES DEPARTMENT OF AGRICULTURE FOR 1910 appears again in the form with which all students of State-aided agriculture are now familiar. The report of the Secretary unfolds the usual marvellous tale of American agricultural prosperity, and the fact that the annual value of agricultural products in the States is estimated to have nearly doubled in the last 12 years justifies, at all events from the producers' point of view, the optimism that is the keynote of these reports.

Of individual crops cotton now comes second in total value, being exceeded only by maize. Interesting information is given concerning these two crops. Of cotton it is said that it "yields a marketable product with less water than any other crop now grown in the South West," and it is implied that the production of cotton in America can still, in spite of the boll weevil, be enormously increased.

A statement that carefully bred varieties of cotton have been found to be abnormally variable when introduced to a new locality, and that re-selection for some years is necessary before the normal yield is obtained, throws a suggestive light on the failure of many of the attempts that have been made to introduce exotic varieties into India. A type of Egyptian cotton has been bred and successfully grown on a field scale in South California and Arizona, and varieties of the well-known Mit-Afifi have been acclimatised by selection.

One of the most effective means of improving the cultivation of maize has been the formation of "Corn-Clubs," to which over 46,000 boys in the States now belong. These clubs give prizes for the growth of large yields of maize; and boys, after studying the improved methods advocated, have succeeded in growing up to 200 bushels per acre, on their fathers' farms, at a low cost. It is found that these methods are very rapidly adopted as a result of this system of demonstration.

While these typically American crops are thus continually being developed at one end of the scale, the maintenance and enhancement of the vigour of imported staples is being systematically

ensured at the other. With characteristic enterprise and remarkable insight the Americans have gone to the scenes of the beginnings of man's dominion over nature for this purpose. The explorers of the office of Plant Introduction have found wheat growing wild on the slopes of Mount Hermon; apricots, cherries, olives, alfalfa and another species of Medicago, in Turkestan; grapes, peaches, crab apples and a strawberry in the Caucasus; all possessing either in their produce or in their capacity to resist drought and cold, qualities which it is hoped to utilise by grafting or crossing with American staple varieties.

The Department's activities cover a wide field; the importance of controlling rats by making the permanent conditions unsuitable for their increase is mentioned in another section of the report, in which it is also stated that the California ground squirrel has become infected with plague. When the number of small rodents in America and their wide distribution is considered, it can only be hoped that the prairie dogs of the middle West are not destined to play the same part in harbouring plague in America as the marmots, from Manchuria to the Caucasus, are now supposed to play in Asia.

It is impossible adequately to review these reports in a limited space. Incidentally they give the impression, to one who has not been in America, that agriculture there is still in its infancy, but the truth probably is that, in the development of farming on extensive lines, the old knowledge fell largely into disuse in the necessity for, and advantages of, development in a totally different direction. The Yearbook, naturally enough, does not concern itself much about points in which the American practical farmer already excels. It is remarkable that out of 476 pages—excluding the appendix—the space devoted to the horse and the pig consists of two short paragraphs, on army horses, and on swine fever, which together would occupy exactly one page. A reference to the statistics in the appendix, however, shews that there are 21 million horses and 47 million pigs in the States—over four times as many horses and five times as many pigs per head of the population as in the United Kingdom.

The horse is the backbone of American agriculture, and the pig must play much the same part in the economy of the disposal of crops under the American extensive system, that the horse does in their production. Meanwhile the possibilities of the development of intensive cultivation have, over a large part of the country, apparently been lost sight of and remain to be exploited. How the United States Department of Agriculture is taking advantage of this fact, while keeping well to the fore in original investigations, this and previous Yearbooks show.

From this point of view and owing to the valuable statistics it contains, the Yearbook will always be of interest to students of agriculture and economics outside America; but the agriculturist in older countries must not expect to find in it the information which would be of most value to him—the details of the methods, of the intelligent use of livestock, by which the American farmer who has not got any great stock of capital, can pay an average wage of nearly a dollar a day and yet make farming pay.—(A. C. DOBBS.)

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"NOTES ON CLASSIFICATION AND EXAMINATION OF THE CANES AT PRESENT INDIGENOUS TO BENGAL."—By C. S. Taylor, B.A., Departmental Records, Department of Agriculture, Bengal. Twenty-five varieties of sugar-cane, all indigenous to Bengal, have been grown at Sabour and examined, at intervals, during the ripening period. Data regarding proportions of juice expressed, the estimated amount of sugar left in the begass and the composition of the juice are given.—(J. W. LEATHER.)

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"THE REVENUE ADMINISTRATION OF THE UNITED PROVINCES."—By W. H. Moreland, C.I.E., I.C.S., published by the *Pioneer Press*. We are glad to see this the latest volume from the pen of Mr. Moreland. Starting with a brief résumé of the earliest revenue system, dating as far back as 1300, the author conducts the reader by easy stages through the period of Mahomedan rule to the revenue settlements of the past century and the present

time. The term "landholder" is explained in Chapter VII. In the following chapter the amount of revenue and its relation to the total produce are made clear. Following this are details of tenancy legislation in the two Provinces. Thirteen chapters are then devoted to an explanation of the Land Record System, rent litigation and collection of revenue. Chapter XXVI is devoted to an explanation of the Principles of Famine Relief. The remaining seven chapters are devoted to agricultural deterioration and improvement and to Co-operative Credit. In his Introduction the author explains that the volume has been written principally for the advantage of the young members of the Indian Civil Service when first becoming acquainted with district revenue work. Mr. Moreland's efforts will no doubt meet with ample success in this respect; indeed, we may go further and express the belief that the book will be found of considerable interest to members of other Indian Services who come into contact with the people. The volume is written in Mr. Moreland's lucid style and sets out graphically the difficulties which frequently beset the revenue officer. A quotation from Chapter XXIII on "Partitions" will illustrate this :—"probably the division of the site (abadi) causes more friction than matters of much greater pecuniary importance; questions of the right to a yard on which the houses of several claimants open, look petty in court, but their importance can be realised when the court is held, for the time being, in the yard in dispute, and the proceedings can include the interjections of the ladies of the families affected; and it is probably the experience of a good many officers that a large site cannot be partitioned satisfactorily except on the spot."—(J. W. Leather.)

LIST OF AGRICULTURAL PUBLICATIONS IN INDIA FROM THE 1ST FEBRUARY TO THE 31ST JULY 1911.

No.	Title.	Author.	Where published.
		General Agriculture.	
1	The *Agricultural Journal of India*, Vol. VI, Parts II and III. Price per part, Rs. 2. Annual subscription Rs. 6.	Agricultural Research Institute and College, Pusa, Bengal.	Messrs. Thacker, Spink & Co., Calcutta.
2	Report on the Flax Experiments conducted at Dooriah during the year 1910-11. Bulletin No. 25 of the Agricultural Research Institute, Pusa. Price 6 annas or 7 pence.	E. M. Vandekerkhove, Flax Expert to the Behar Planters' Association.	Government Printing, India, Calcutta.
3	Note on the Present Position of Cotton Investigation in India. Bulletin No. 26 of the Agricultural Research Institute, Pusa. Price 2 annas or 3 pence.	Bernard Coventry, Offg. Inspector-General of Agriculture in India.	Ditto.
4	Annual Report of the Board of Scientific Advice for the year 1909-10. Price Re. 1.	Board of Scientific Advice for India.	Ditto.
5	Area and Yield of certain Principal Crops in India for periods from 1896-97 to 1910-11. Price 4 annas or 6 pence.	Commercial Intelligence Department, India.	Ditto.
6	Notes on Sugar in India. Price Re. 1-12.	F. Noel Paton, Director-General of Commercial Intelligence, India.	Ditto.
7	Report of Flax Work at Dooriah Factory for the year 1909-10.	E. M. Vandekerkhove, Flax Expert to the Behar Planters' Association.	Ross & Co.'s Press, Muzafferpore.
8	The Cultivation of Guavas near Poona, Dharwar and Limbgaon. Bulletin No. 40 of 1911. Price 12 annas or 1 shilling 2 pence.	L. B. Kulkarni, L. Ag., Probationer under the Economic Botanist, Bombay.	Government Central Press, Bombay.
9	Groundnuts in the Bombay-Deccan. Bulletin No. 41 of 1911. Price 4 annas or 5 pence.	G. K. Kelkar, Asst. Prof., Agricultural College, Poona.	Ditto.
10	Note on Long-stapled Cotton in Sind. Bulletin No. 42 of 1911. Price 3 annas or 3 pence.	G. S. Henderson, N.D.A., N.D.D., Deputy Director of Agriculture, Sind.	Ditto.
11	An Examination of the Seed Supply of the Broach District. Bulletin No. 43 of 1911. Price 5 annas or 6 pence.	G. D. Mehta, L. Ag., B.A., N.D.A., N.D.D., Probationer in charge Seed Testing Operations.	Ditto.
12	Cultivation of Broach Cotton in Dharwar. Translation in Canarese of Bulletin No. 33. Price 4 annas.	M. L. Kulkarni, Divisional Inspector, S. D., Bombay Presidency.	Ditto.
13	The Mandalay Experimental Station. Cultivator's Leaflet No. 26.	Department of Agriculture, Burma.	Government Press, Burma, Rangoon.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
14	Notes on Tree Cotton Cultivation in Burma. Cultivator's Bulletin No. 5.	E. Thompstone, B.Sc., Deputy Director of Agriculture, Burma.	Government Press, Burma, Rangoon.
15	Season and Crop Report of Burma for the year ending 30th June 1911. Price 6 annas or 6 pence.	Department of Agriculture, Burma.	Ditto.
16	Scientific Report of Agricultural Station, Samalkota, for 1910-1911.	G. R. Hilson, B.Sc., Deputy Director of Agriculture, Northern Divn., Madras.	Government Press, Madras.
17	Scientific Report of Agricultural Station, Hagari, for 1910-11.	Ditto.	Ditto.
18	Ditto, Bellary, for 1910-11.	Ditto.	Ditto.
19	Scientific Report of Agricultural Station, Nandyal, for 1910-1911.	Ditto.	Ditto.
20	Scientific Report of Agricultural Station, Central Farm, Coimbatore, for 1910-11.	R. Cecil Wood, B.A., Principal, Agricultural College, Coimbatore.	Ditto.
21	Scientific Report of Agricultural Station, Palur, for 1910-11.	H. C. Sampson, B.Sc., Deputy Director of Agriculture, Southern Division, Trichinopoly, Madras.	Ditto.
22	Scientific Report of Agricultural Station, Koilpatti, for 1910-1911.	Ditto.	Ditto.
23	Scientific Report of Agricultural Station, Taliparamba, for 1910-11.	Ditto.	Ditto.
24	The Home Farm, Sivagiri Estate, Tinnevelly District, Madras, Bulletin No. 62, Vol. III. Price 6 annas or 6 pence.	J. M. Lonsdale, N.D.A., N.D.D., Agricultural Expert, Court of Wards, Madras, assisted by A. Rama Rao Avargal.	Ditto.
25	Note on Sugarcane Cultivation on the Western Coast. Leaflet No. 2 in Malayalum.	Umikrishna Menon.	Government Press, Madras.
26	A Dialogue on Single Planting of Paddy. Leaflet No. 3, in Tamil.	Kolandamlu Udayar.	Ditto.
27	A Note on Wild Indigo. Leaflet No. 4, in Tamil and Telugu.	A. Rama Rao, Home Farm Superintendent, Sivagiri.	Ditto.
28	Improvements in Ryats' Lands. Leaflet No. 6, in Telugu and Uriya.	G. R. Hilson, B.Sc., Deputy Director of Agriculture, Northern Division, Madras.	Ditto.
29	Advantages of using Iron Ploughs in Black Cotton Soils. Leaflet No. 7, in Telugu.	Ditto.	Ditto.
30	Manuring in the Kistna. Leaflet No. 9, in Telugu.	Ditto.	Ditto.
31	Dhaincha—*Sesbania Aculeata*—New Green Manure Crops. Leaflet No. 10, in English, Tamil and Telugu.	H. C. Sampson, B.Sc., Deputy Director of Agriculture, Southern Circle, Madras.	Ditto.
32	Cambodia Cotton. Leaflet No. 11, in Canarese.	G. R. Hilson, B.Sc., Deputy Director of Agriculture, Northern Division, Madras.	Ditto.
33	Reprint of Single Planting of Paddy and Green Manuring, in Tamil.	H. C. Sampson, B.Sc.; and C. Narayan Iyer.	Ditto.
34	Lists (5) of Seeds available for Sale in Northern Division, in Telugu.	G. R. Hilson, B.Sc.	Ditto.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
35	Note on Sugarcane Cultivation. Leaflet No. 13, in English.	M. Govinda Kidaore.	Government Press, Madras.
36	Hints to Owners of Ginning Factories. Leaflet No. 16, in English.	M. E. Couchman, I.C.S., Director of Agriculture, Madras.	Ditto.
37	Some Hints for Agricultural Associations, Bulletin No. 9.	Central Agricultural Committee, Madras.	Ditto.
38	Some Insect Pests of India. Bulletin No. 10.	Ditto.	Ditto.
39	Recommendations for the Work of the Department in assisting the Agricultural Shows of Bengal. Departmental Record No. 2 of 1910 (not for sale).	E. J. Woodhouse, B.A., Economic Botanist, Bengal.	Bengal Secretariat Press, Calcutta.
40	Agricultural Statistics of Bengal for 1909-10. Price Re. 1-4.	Department of Agriculture, Bengal.	Ditto.
41	Season and Crop Report of Bengal for 1910-11. Price 6 annas.	Ditto.	Ditto.
42	*Quarterly Journal of the Department of Agriculture, Bengal*, Vol. IV, Nos. 3 & 4 (January and April 1911). Price 6 annas per part.	Ditto.	Ditto.
43	Annual Report of the Agricultural Stations in Eastern Bengal and Assam, for the year 1909-10. Price annas 12.	Department of Agriculture, E. B. and Assam.	Government Secretariat Press, Shillong.
44	A Circular Letter to Cultivators in the Khasi Hills (Khasi and English).	Ditto.	Government Press, Shillong.
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46	Rules for Supply of Seeds, Manures and Implements at Reduced Rates, to Honorary Correspondents and Associates of the Department of Agriculture, Eastern Bengal and Assam.	Ditto.	Ditto.
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54	Cattle and Dairying in the Punjab.	Department of Agriculture, Punjab.	*Civil and Military Gazette* Press, Lahore.
55	Annual Report of the Department of Agriculture, Baroda State. Price annas 4.	Department of Agriculture, Baroda.	Baroda Printing Works.
56	Report on the Work done on the Rangpoor Farm. Price 2 annas.	......	R. P. W. Co., 154, Upper Chitpur Road, Calcutta.
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60	The Preservation of Farm Yard Manure. Leaflet No. XIV, in English, Tamil and Telugu.	W. H. Harrison, M.Sc., Agricultural Chemist to the Government of Madras.	Government Press, Madras.
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62	Instructions for sending plants attacked with parasitic Fungi. Leaflet No. 1 in English.	W. McRae, M.A., B.Sc., Mycologist to the Government of Madras.	Government Press, Madras.
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65	The Milling and Baking Qualities of Indian Wheats No. 3. Bulletin No. 22 of the Agricultural Research Institute, Pusa. Price 7 annas or 8 pence.	A. Howard, M.A., A.R.C.S., F.L.S., Imperial Economic Botanist, and Gabrielle L. C. Howard, M.A., Personal Assistant to the Imperial Economic Botanist, Associate and Late Fellow of Newnham College, Cambridge.	Government Printing, India, Calcutta.
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68	A Note on Concoanut Beetles. Leaflet No. 8 in English, Malayalam, Canarese, Tamil and Telugu.	Ditto.	Ditto.
69	Flora of the Upper Gangetic Plain and of the adjacent Siwalik and Sub-Himalayan Tracts, Vol. II. Price Rs. 2 or 3 shillings.	J. F. Duthie, B.A., F.L.S., formerly Director of the Botanical Department of Northern India.	Government Printing, India, Calcutta.
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